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VALIDITY OF INDUCED ENVIRONMENTAL
CRITERIA

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Boeing Vertol Company

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5 percent of the failures were caused by induced environmental factors. Four of the nine causal factors were significant in 95 percent of these failures. Of the remaining five factors, three were responsible for the remaining 5 percent of environmental failures and two had no discernible causal effect on the failure rate.

The potential adverse effect of the induced environmental factors on next-generation helicopters was assessed for two aircraft currently in the design development stage. State-of-the-art advances in design, materials, and processes indicate that such effects will be generally less significant than those experienced on current Army aircraft.

Ninety-one specifications, standards, design guides, and test procedures were analyzed for validity of design and test criteria applicable to the components affected by the four significant induced environmental factors. Seventy-nine of these documents were found to be pertinent to the study. Of these, 52 (66 percent) were judged to be inadequate on the basis of new criteria established to insure consideration of induced environment, safety, reliability, and maintainability in design and test requirements. Recommendations are presented for specific revisions to the 52 documents judged to be inadequate.

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PREFACE

This report presents the results of a study of the validity of induced environmental criteria in Army aircraft design and test requirements. The study was conducted by the Boeing Vertol Company for the Eustis Directorate, U.S. Army Air Mobility Research and Development Laboratory (USAAMRDL), Ft. Eustis, Virginia, under Contract DAAJ02-73-C-0069 (DA Task 1F262209AH76).

USAAMRDL technical direction was provided by Mr. Donald R. Artis, Jr.

The Project Engineer and principal investigator for the Boeing Vertol Company was Mr. John F. Bell of Product Assurance R&D Hardware Programs. He was assisted by Ms. J. Vivaldi and Messrs. K. Anderson and R. Millay of Data Central, and various product support and engineering design specialists.

Program management and technical direction were provided by Mr. R. B. Aronson, Manager of Product Assurance R&D Hardware Programs at Boeing Vertol.

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INTRODUCTION

The environmental conditions to which Army helicopters are exposed contribute significantly to reliability and maintainability (R&M) shortcomings. It has been determined that the environmental criteria used in the past to stipulate environmental design and test requirements are in many cases antiquated in relation to Army helicopter technology. Consequently, efforts have recently been initiated to define the operational environment upon which more accurate environmental design and test requirements for future Army aircraft can be based.

Specifically, research and development efforts are currently under way to define and document the worldwide natural environment and to determine the influence of this natural environment upon various Army aircraft types. To date, the induced environment has not been adequately covered. The induced environment is primarily composed of those environmental factors which are imposed upon the aircraft by itself and its mission requirements and by man in the process of aircraft maintenance, handling, and air or ground transport. Since the natural environment design and test criteria for Army aircraft are, in general, antiquated or inadequate, it is suspected that the induced environmental design and test criteria and requirements are similarly inadequate.

This study therefore comprised the following efforts:

- First, certain induced environmental factors were examined, and their effects on current Army aircraft were quantified.
- Second, the potential effects of these factors on new design concepts and state-of-the-art improvements in materials and processes were qualitatively assessed for next-generation aircraft.
- And finally, the validity of environmental design and test criteria contained in related specifications, design guides, and test procedures was reviewed for systems, subsystems, and components which exhibit significant reliability problems. Where these documents were shown to be deficient when assessed against adequate criteria, specific revisions were recommended. The need to develop new documents was also assessed.

In this manner, it is believed that many of the current deficiencies in induced environmental criteria for design and test can be identified and remedied to the benefit of future Army aircraft.

INDUCED ENVIRONMENTAL FACTORS

Natural environmental factors, such as humidity, wind, temperature, precipitation, and soil particles, result purely from exposure to conditions of weather or geographical location. Induced environmental factors are, as the name implies, of manmade origin. They are the environmental conditions imposed upon the aircraft by its own design configuration; its functional or mission requirements; and the requirements for maintenance, servicing, and transport. Figure 1 portrays the scope of environmental stresses in both categories.

The factors shown on Figure 1 which are not addressed by this report are being or have been defined under other Government efforts and are therefore not considered part of this effort.

The following induced environmental factors are the subject of this study:

- Temperature or thermal shock
- Ozone (O₃) generated by the helicopter
- Aircraft operating fluids
- Field cleaning materials and techniques
- Mechanical shock of normal landing and gust loads
- Animal fluids, secretions and excrements
- Aircraft transport
- Rodent damage
- Internal airflow patterns and contamination

Before analysing their effect on current Army aircraft, these factors will be defined and discussed in greater detail. Definition is necessary to assure understanding of the scope or limitations of each specific factor and discussion provides a rationale for such limitations based, in most instances, on analysis of the field experience data. This is consistent with good engineering procedure, although it may seem like placing the cart before the horse. In other words, prior to the field data analysis, the scope and effect of these factors were ill-defined and based on hearsay, empirical knowledge, or isolated reports. The data analysis enables better qualification as well as quantification of the induced environmental factors, both of which are essential to their definition.

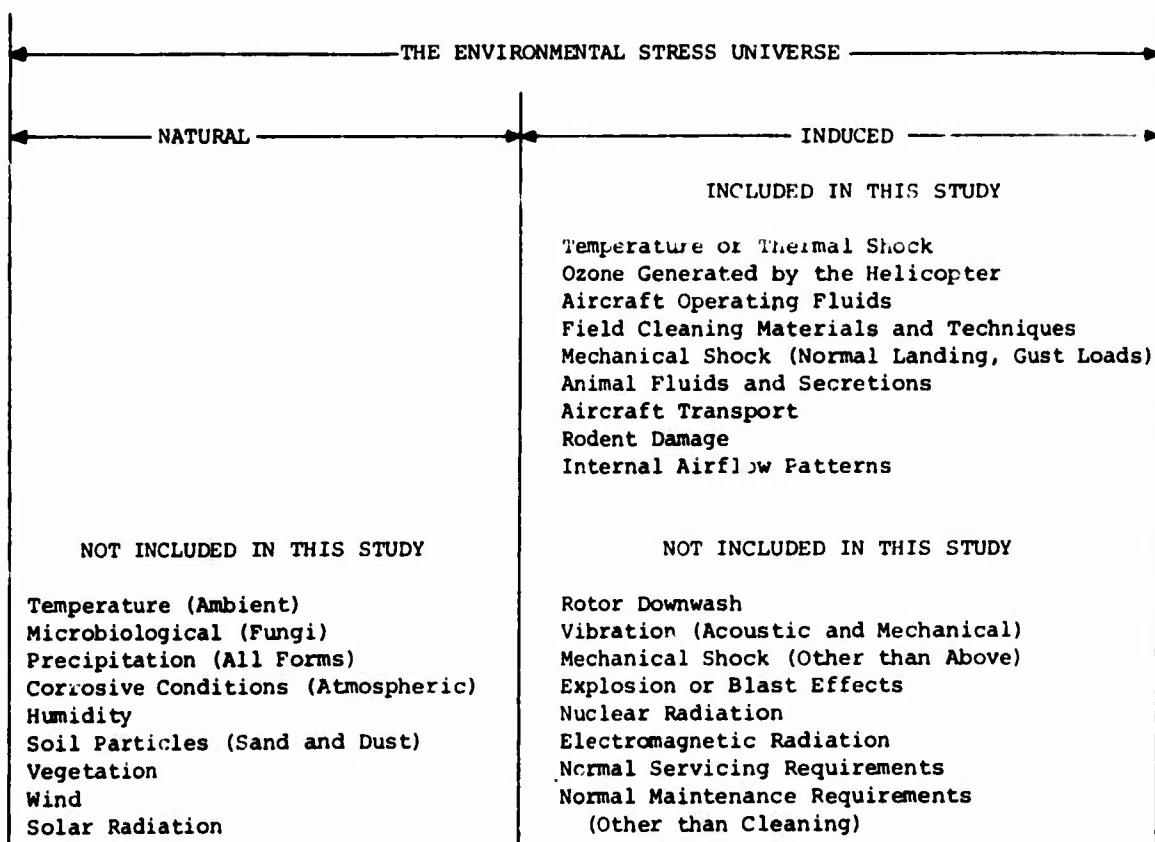


Figure 1. Scope of Helicopter Environmental Stresses.

TEMPERATURE OR THERMAL SHOCK

This study is concerned with excessive temperatures, generated by equipment operation in enclosed compartments, which result in premature failure or malfunction. Atmospheric or ambient temperatures may aggravate or reduce the effect of such conditions, but are considered to be of the natural environmental category, and are not treated in this study except as they may affect upper or lower limits of component operation or create shock due to rapid change. Basically, the designer must be aware, by empirical or test data, of the allowable operational limits of the equipment, and he must design the installation to meet those limits under the anticipated environmental conditions, both natural and induced.

Thermal shock resulting from rapid changes in temperature must also be recognized in helicopter component design because of the potential for damage in high-altitude air transport. It is not considered significant in Army helicopter operational reliability, however, because of the relatively low altitudes at which flight operations are normally conducted. While helicopters may frequently be operated from base locations higher than sea level, the operational altitude is still primarily limited to a 2000- to 5000-foot spread which at the standard lapse rate, represents a maximum temperature change of 16.5°F from the base level.

As the failure rate data in Table V shows, temperature extremes have the most significant effect on electrical and electronic equipment. Such equipment generates varying degrees of heat in performing normal functions and is uniquely susceptible to deterioration and malfunction as a result. The very high failure rate of only three receiver/transmitter units in one model helicopter was the major contributory cause for the high priority of this induced environmental factor. The document analysis in Appendix III includes both installation and test specifications for these specific electronic units. While the installation specifications do not meet the study criteria, they are quite clear in the specification of operating temperature limits. The test documents are deficient in requirements for environmental testing and R&M demonstrations. It is quite apparent that if such tests had been made, the corrective action (louvers in the compartment doors) could have been taken before production aircraft delivery.

Engine compartments also sustain high temperatures which can adversely affect components and accessories. However, the data analysis did not reveal current problems in this area. Such problems are sufficiently critical to receive corrective action early in the development test phase and are unlikely to appear in the mature aircraft involved in this analysis.

OZONE GENERATED BY THE HELICOPTER

Ozone is a bluish gas which has a characteristic odor and is most commonly formed in air by an electrical discharge such as lightning or by the arcing of electric motors. It is also formed naturally by the action of sunlight on oxygen in the upper atmosphere and by the reaction of sunlight with nitrogen trioxide (NO_3) emitted in the combustion process and resulting in photochemical smog.

Although its properties are different from those of ordinary oxygen, ozone is not a compound but is elementary oxygen in a different form known as an allotrope. Ozone (O_3) holds three atoms in the molecule instead of two, as in ordinary oxygen (O_2), and therefore oxidizes organic substances much more readily than oxygen. It is used for industrial bleaching, drinking water purification, cold storage food preservation, and various other chemical processes. Rubber is made brittle and deteriorated by ozone in the air, and therefore the effect of sunlight on certain helicopter elastomeric design applications requires serious consideration.^{1,2}

However, there is no evidence of problems in current helicopters from ozone generated by the helicopter. Slight traces of ozone may result from electric arcing and static discharge from rotor blade tips, but the concentration is too low to show significant or recognizable effects.

AIRCRAFT OPERATING FLUIDS

For the purpose of this study, aircraft operating fluids are defined as those fluids required for the normal functional operation of the aircraft systems. Such fluids include fuel, lubricating oil, grease, hydraulic fluid, water, oxygen, nitrogen, and antifreeze.

Fluids tend to leak or escape from containment and spread to form a surface film or collect in low spots, crevices, or hollows throughout the aircraft. They will then often react to cause deterioration or corrosion, depending on the material with which they are in contact. Deterioration is the degeneration of effective material properties and is most common in elastomeric materials, some composites, plastics, paints, and nonslip compounds. Corrosion is the destruction of a metal by chemical or electrochemical reaction with its environment. The initiation and propagation of corrosion may differ depending on whether the metal is immersed in a fluid or exposed to a corrosive atmosphere, but the results are the same.

Oil, water, and hydraulic fluid films attract and hold fine soil particles which contaminate bearings, seals, cables, and close tolerance mechanisms, thus causing premature malfunction or failure. Some combinations of airborne pollutant particles with fluids may create more than a purely abrasive compound. Depending upon the combined chemical makeup of the fluid and the pollutant particles, deterioration or corrosive action may be generated in addition to the abrasive action.³

While water is listed among the operating fluids, it has little functional use in helicopters. Its primary sources are natural: rain, snow, and condensation of atmospheric moisture. The chief source other than these is from washing the aircraft. The problems arising from aircraft washing practices are considered under a separate environmental factor, but the failure modes are often indistinguishable from natural moisture causes. Consequently, all moisture corrosion problems are included in the operating fluids group unless they can be positively identified with washing or cleaning procedures and practices.

The data analysis shows that aircraft operating fluids have a more widespread and detrimental effect on the reliability of helicopter subsystems and components than all other factors of this study combined.

CLEANING MATERIALS AND TECHNIQUES

Aircraft field cleaning materials and techniques are significant factors in helicopter reliability. Proper and timely washing or cleaning of the aircraft and its component parts is essential to good preventive maintenance and reduction of premature failures. However, improper techniques or materials can aggravate the environment and accelerate failures. For example, windshields may be scratched by wiping dust off with a dry cloth, instead of washing with mild detergent and water as specified in maintenance instructions. Moreover, the windshield may become hazy unless flushed after exposure to the alkaline waterbase cleaner approved for fuselage exterior surfaces. Close adherence to published maintenance instructions is essential to ensure the maximum beneficial effect from cleaning and washing procedures.

As noted in the discussion of aircraft operating fluids, moisture corrosion due to washing techniques is not readily distinguishable from that due to natural causes unless specifically reported as such. Therefore, failure data on corrosion modes will not be attributed to cleaning techniques unless qualitative evidence supports such a conclusion. In any event, washing and cleaning are included with other preventive measures in the documentation review for validity of corrosion criteria.

MECHANICAL SHOCK OF NORMAL LANDING AND GUST LOADS

This environmental factor is identified in recognition of the fact that, when a design load is operationally exceeded on a continuing basis, it may come to be accepted as normal but still generate reliability problems. Thus under combat conditions, landings may be considered normal even though they repeatedly place greater than normal stresses on certain components. Wind gusts may induce rotor blade stresses or cause blade/fuselage contact and resultant damage when they are treated as commonplace, and good preventive measures are ignored.

Thus, while rotor blades may be secured in accordance with maintenance instructions in anticipation of high or gusty winds (classified in the natural environment), severe blade stresses due to flapping may result more frequently from the downwash of nearby helicopters (induced environment), because maintenance personnel consider such stresses normal or routine and do not take preventive precautions.

Failures resulting from this environmental factor tend to reflect on the local maintenance and operational practices and are therefore seldom reported in sufficient detail for good data analysis. The data available in this study was inadequate for good quantitative assessment of this environmental factor.

ANIMAL FLUIDS, SECRETIONS, AND EXCREMENTS

This environmental factor, entitled animal fluids, etc., encompasses human secretions including blood, which is of particular concern in medical evacuation missions. The overall effect of this environmental factor is one of corrosive action in fuselage structure, skin, and flooring. Preventive measures include proper material, protective coatings, and frequent washing per maintenance instructions. However, the failure data usually does not distinguish this causal factor from others which corrode or deteriorate the aircraft structure. Thus the significance of this factor in itself is lost in the general corrosion from fluids category, where it is included for the specification review of environmental criteria.

TRANSPORTING THE AIRCRAFT

This induced environmental factor embodies the conditions to which the helicopter and its systems are exposed during transport by air, sea, or land; the effects of ferrying the aircraft under its own power are excluded. The following conditions could be detrimental to the aircraft:

- In transport by air, there is danger of mechanical shock and vibration from landing, takeoff, or gust loads and of thermal shock from rapid temperature changes.
- In transport by sea, there is danger of some shock if the aircraft is not adequately secured and local vibration if it is not properly positioned onboard ship.
- In normal motor transport operations, shock and vibration are low; on unimproved roads, vertical shocks and vibration can be detrimental.
- In transport by rail, shocks can be high, depending on velocities of humping impacts.
- In all modes, there are potential dangers in special disassembly or assembly requirements and the attendant problems of safe packing and storage of loose parts or components. Also, there must be adequate protection from exposure to natural elements. This is most critical for the sea mode and least critical for air transport.

The failure data relating to aircraft transport is minimal but the data available may not indicate its real significance. The dearth of reported problems can be attributed to several factors:

- The problems are not directly related to operation of the helicopter and thus are not reported as diligently as they otherwise might be.
- Some problems may not appear until long after exposure and thus are not traceable to such causes.
- The conditions for potential damage are extremely nebulous in the mechanical shock and vibration areas.
- Protection from exposure to the elements is well documented by procedures and packaging regulations.
- Air transportation is most frequently used and presents the least chance for damage to the helicopter.

RODENT DAMAGE

On the basis of evidence found in this study, rodent damage to helicopters is confined to electrical wiring. The incidents have not been documented adequately to establish a valid

failure rate and have apparently occurred only on those aircraft equipped with loading ramps. Such configurations are conducive to rodent access to the aircraft cargo compartment and may, by virtue of the cargo or personnel transport mission, be more likely to contain scraps of food, which initially attract the rodents. In any event, there is no evidence of such a problem in either the large CH-54 (which presents access difficulties) or the smaller utility and observation helicopters.

INTERNAL AIRFLOW PATTERNS AND CONTAMINATION

This factor, rather than affecting the helicopter reliability in terms of a component failure or malfunction, is included among the induced environmental conditions because of its potential to affect the mission. The several aspects of this factor are:

- Contamination of cockpit air due to flow patterns which permit air from the cargo compartment to enter the cockpit bearing contaminants of dust, debris, smoke, or noxious fumes;
- Airflow patterns that permit a fire path from the engine compartment into the main fuselage; and
- Inadequate cooling and ventilating of the cockpit area.

The data analysis gives evidence that these factors are uniquely related to the CH-46/CH-47 type of cargo configuration. However, they should be considered in the design of the next generation of Army helicopters.

METHODS AND PROCEDURE

As an introduction to the methods and procedure used in conducting this study, a brief reiteration of the purpose of the work is pertinent:

- Each of the induced environmental factors was examined to determine its limits and significant effects on helicopter reliability and maintainability.
- The validity of each environmental factor, as a realistic design and test environment, was assessed for application to future Army helicopters in existing specifications, standards, design guides, or other documentation.
- Where existing design and test requirements and procedures are found to be inadequate, changes are recommended based on new criteria.

The first step is to relate the given induced environmental factors to actual helicopter component malfunctions, failures, or removals. This process requires qualitative problem identification and then quantification in terms of component failure rate and/or unscheduled maintenance man-hour rate per unit of flight time. Quantification in either or both of these forms enables assessment of problem significance and prioritization for document review.

PROBLEM IDENTIFICATION

Data Scope

Problems were investigated and identified for seven existing Army helicopters representing the current weight and mission spectrum. For comparison purposes one Navy/Marine assault/cargo type helicopter was included in the analysis. The helicopters analyzed are shown in Table I with their respective manufacturers, missions, and gross weights.

Data Sources

The data sources used for problem identification were many and varied. These sources and their applicability to the helicopters analyzed are shown in Table II. Qualitative information in the form of narrative description was essential for associating the problems with the appropriate induced environmental causal factors. Failure rate and maintenance manhour rate were just as essential. The combination of all three of these factors was frequently unavailable. The section on problem

quantification discusses the method used to assess problem significance. Table II shows the capability of each data source to provide qualitative and quantitative information.

TABLE I. REPRESENTATIVE HELICOPTERS				
Designation	Popular Name	Manufacturer	Typical Mission	Max Gross Weight (lb)
CH-54B	Tarhe	Sikorsky Aircraft Division (United Aircraft Corp.)	Cargo/Transport	47,000
CH-47C	Chinook	Boeing Vertol Co. (Division of The Boeing Co.)	Cargo/Transport	46,000
CH-46D	Sea Knight	Boeing Vertol Co. (Division of The Boeing Co.)	Assault/Cargo	23,000
UH-1C, D	Iroquois	Bell Helicopter Co.	Utility	9,500
AH-1G	Cobra	Bell Helicopter Co.	Attack	9,500
OH-58A	Kiowa	Bell Helicopter Co.	Observation	3,000
OH-6A	Cayuse	Hughes Tool Co.	Observation	2,700

PROBLEM QUANTIFICATION

Data Parameters

The basic R&M parameters for quantification of the induced environmental problems are identified in this study as failures per unit of time and maintenance man-hours per unit of time. The reliability parameter is closely allied with the maintainability parameter, since it represents the frequency of performing unscheduled maintenance on the aircraft as a result of real or suspected component degradation. Three levels of degradation exist: failure, malfunction, or discrepancy. In this report all three of these levels are included in the term failure. They are defined as follows:

TABLE II. RELIABILITY AND MAINTAINABILITY DATA SOURCES AND APPLICABILITY													
Data Identification		Data Source	Calendar Time Period If Applicable	Qualitative	Data Type Quantitative	Helicopter Applicability							OH-6A
Number	Nomenclature					CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	GA-58	
EIR	Equipment Improvement Request	U.S. Army Field Units	-	X		X	X		X	X	X	X	X
TB 750-992	EIR Digest	AVSCOM	-	X		X			X		X		
EPR	Equipment Performance Report	Aviation Test Board, Fort Rucker	1967, 68, & 69	X			X						
RCS AMC QA-113	Management Summary Report	AVSCOM	Variable		X				X		X	X	X
TR 72-11	Identification and Analysis of Army Helicopter R&M Problem and Deficiencies	USAMRD 1972	Variable	X		X			X		X		
TR 73-28	Investigation and Analysis of R&M Problems of Army Aircraft Engines	USAMRD 1973	1/69 to 12/70	X								X	X
114RE600	U.S. Army Engineering Field Evaluation Program	AVSCOM/Boeing Contract DAAJ01-68-C-1591	6/67 to 8/69	X	X		X						
3M	Maintenance Material Management	U.S. Navy	1969 & 1970		X			X					
U.R.	Unsatisfactory Report	U.S. Navy	-	X				X					
D.I.R.	Disassembly Inspection Report	U.S. Navy/Boeing	-	X				X					
D210-10538-1	CH-47 R&M Field Experience	Aviation Test Board, Ft. Rucker/Boeing Study	6/69 to 9/70	X	X		X						
FSR	Field Service Report	Boeing Vertol Co.	-	X			X	X					
DPR	Design Problem Report	Boeing Vertol Co.	-	X			X	X					
ECP	Engineering Change Proposal	Boeing Vertol Co.	-	X			X	X					
205-099-157	Problem Analysis, Corrective Action Summary, and Recommendations	Bell Helicopter Co.	-	X					X	X	X		
205-099-172	UH-1 M&R Program Quarterly Progress Report	Bell Helicopter Co.	10/67 to 1/68		X				X		X		
HTC-AD 70-66	Quarterly Reliability Report OH-6A	Hughes Tool Company	4/69 to 3/70	X	X								X

- Failures represent component degradation to the point where function is essentially lost.
- Malfunctions represent a lesser degree of degradation, usually noticeable either in terms of the component's appearance or some external manifestation such as high vibration; however, the ability to perform the function is still present, and unscheduled corrective maintenance may occur immediately or be deferred.
- Discrepancies represent conditions where corrective unscheduled maintenance is appropriate to prevent subsequent progressive component degradation (for example, repositioning of a chafing hydraulic line), the unscheduled maintenance may be performed immediately or deferred.

While the recording of failure frequency and mode information is relatively straightforward, the identification of corrective unscheduled maintenance activities taking place on the aircraft is less clearly distinguishable. Basic requirements for valid maintenance data are noted below.

The data must reflect every unscheduled maintenance event that occurred at the organizational level during the designated time period; otherwise, erroneously low rates will be calculated. There must be no periods of time where flight hours are accumulated, but where unscheduled maintenance is either not recorded or the records are unavailable. Also, there must be no unscheduled maintenance that is consistently not recorded (for example, repositioning of chafing lines).

Duplicate counting of maintenance events must not occur. Unscheduled maintenance occurring at the organizational level often causes subsequent related unscheduled maintenance off aircraft at higher maintenance levels. The data system must be capable of identifying that the downstream maintenance was related to an earlier maintenance event. Scheduled maintenance (for example, servicing, scheduled inspection, scheduled removals) must also be identifiable so that these events can be excluded.

Data Analysis

All applicable data sources were reviewed in detail for each of the eight representative aircraft. For each reported failure that was considered to be environmentally induced, the following information was noted:

- Data source
- Part number

- Part name
- Failure mode
- Environmental cause
- Corrective action if any
- Failures per 1,000 aircraft hours
- Maintenance man-hours per 1,000 aircraft hours

These failures were charted in Table III to reflect the distribution pattern of problems associated with each induced environmental factor. There are 132 problems identified, of which 11 are associated with airflow patterns and are not reported as component failures contributing to the total induced environmental factor failure rate. The remaining 121 problems are associated with 36 different component/failure-mode combinations. Of the 121 recorded problems, 88 are identified with aircraft operating fluids. The next largest environmental causal factor, cleaning materials and techniques, has 15 identified problems, and their modes of failure are closely allied to those of aircraft operating fluids. The third group with similar failure modes is the animal fluids and secretions factor with 4 problems recorded. Thus for the general failure modes of deterioration, corrosion, or contamination, there are 107 identified problems or 89 percent of the total recorded for the nine induced environmental factors. Table III also reflects the generic tendency of these problems, showing fairly even distribution for all the representative helicopter models.

Weight Factors

Further quantification of the problems in terms of the R&M effects is necessary to assess their significance and enable prioritization for document review. As noted above, valid failure rates and maintenance man-hour rates were frequently unavailable. Maintenance man-hours valid for this analysis were available for only about 35 percent of the total recorded problems. In addition, the variables associated with recording of unscheduled maintenance man-hours led to the conclusion that they could not be considered as a valid measure of comparison for problem significance in this study.

Valid failure rates were found for about 60 percent of the problems, and another 10 percent were assigned rates on the basis of similarity. The remaining 30 percent of the problems which could not be validated were assigned weighted numbers based on engineering judgement.

TABLE III. PROBLEM DISTRIBUTION								
Induced Environmental Factor	Number of Failure Modes							
	CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	On-6
A. TEMPERATURE OR THERMAL SHOCK								
1. Electronic Compartment	1					1		
2. Windshield Anti-Icing		1	1					
3. Seal, MR Spindle and Sleeve	1						1	
4. Seal, MR Blade Grip								
B. OZONE (O₃) GENERATED BY HELICOPTER								
1. Electrical Arcing								
2. Electronic Components								
3. Engine Emissions								
C. AIRCRAFT OPERATING FLUIDS								
1. <u>Deterioration (Nonmetal)</u>								
a. Fiberglass			1					
b. Cushion Clamps		1						
c. Terminal Nipples		1						
d. Seals	1	3	1				1	
e. Walkway Coating	1	1	1					
f. Shock Mounts						1	1	
g. Transmission Sight Gage			1					
h. Decals and Identification Tapes		1	2					
i. FM Antenna						1		
j. Gas Producer Control Bellows							1	
2. <u>Corrosion (Metal)</u>								
a. Bearings		1						
b. Connectors	1	1					2	1
c. Control Castings		1						
d. Hubs and Attaching Hardware	2			1	1	1	2	1
e. Airframe Structure/Fittings		1	1			1		
f. Switches	2			2	2		2	
g. Actuators	1						1	
h. Magnetic Brakes		1			1		1	
i. Drive Shafts							1	
j. Indicator, Tachometer							1	
k. Cargo Winch Brake		1						
3. <u>Dirt Contamination/Wear</u>								
a. Bearings	2	1	1	3	3	1	4	1
b. Seals		2	1	2	2	1		
c. Cables				1	1	1		
d. MR Dynamic Droop Stop				1				
e. Generator		1						
D. CLEANING MATERIALS AND TECHNIQUES								
1. Windshields		1	1	1	1			1
2. Airframe			2			1	1	
3. Control System		2						
4. Engine Compressor and Blades						2	1	1
E. MECHANICAL SHOCK (LANDING/GUST LOADS)								
1. Rotor Blade/Fuselage Contact		1	1					
2. Structural Damage		1						
F. ANIMAL FLUIDS, SECRETIONS, ETC.								
Corrosive Effects		2	2					
G. AIRCRAFT TRANSPORT (Air, Sea, Land)								
1. Protection From Elements	2						1	
2. Vibratory Load Damage								
H. RODENT DAMAGE								
Electrical Wiring		1	1					
I. INTERNAL AIRFLOW PATTERNS								
1. Cockpit Air Contamination		3	2					
2. Cooling/Ventilating		1					1	
3. Potential Fire Hazards		4						
Total Failure Modes/Aircraft	17	34	19	12	12	11	22	5

To simplify the process of failure assessment, weight factors were established which provided a single-digit number in place of the actual failure rate. These factors were based on a sliding scale, which gives more relative weight to the lower failure rate problems and reduces the weight effect for higher failure rate items. Since 76 percent of the problems show failure rates of less than one per thousand aircraft hours, this process tends to slightly increase the total failure significance but thereby helps to compensate for prevailing failure reporting deficiencies.

The weight factors established for the purpose of the study are shown in Table IV.

TABLE IV. DATA ANALYSIS WEIGHT FACTORS	
Weight Factor	Failure Rate/1000 Flight Hours
1	0 to 1.00 and *
2	1.01 to 2.00
3	2.01 to 3.00
4	3.01 to 5.00
5	5.01 to 10.00
10	10.01 and up and Mission Affecting Failures
*Valid failure rate data was not available for these problems. A weight factor of 1 was assigned except where a failure rate for a similar mode was available for another aircraft. In such cases the weight factor for the similar mode was used.	

Failure Analysis Summary

Table V presents the identified component, its failure mode, the cause, the system affected, the weight factor, and recorded failure rate. These data are grouped according to induced environmental factors; quantitative data appear in the appropriate helicopter column.

TABLE V. COMPONENT FAILURE ANALYSIS SUMMARY																						
Induced Environmental Factor and Problem Description	System Affected											Helicopter Models										
	Airframe	Com/Hav	Drive	Electrical	Landing Gear	Equipment	Flight Control	Hydraulics	Indicating	Rotor	Powerplant	CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	OH-6A			
												1	2	3	4	5	6	7	8	9	10	11
A. TEMPERATURE OR THERMAL SHOCK																						
1. Electrical/Electronic Compartment																						
a. AFCS Amplifier Malfunctions--Condensation				X								1/*										
b. UHF RT Unit Inoperative--Heat				X														5/9.96				
c. VHF RT Unit Inoperative--Heat				X														5/9.09				
d. FM Radio RT Unit Inoperative--Heat				X														5/9.52				
2. Windshield																						
a. Blisters/Anti-Ice Heat to Dry Dew--Fog						X								1/*	1/.75							
b. Anti-Ice Temp Control Malfunctions Below 0°C						X																
3. Seal, MR Spindle and Sleeve Leaks--Temp Change										X		1/*										
4. Seal, MR Blade Grip Leaks Below 20°F										X									1/.52			
B. OZONE (O₃) GENERATED BY THE HELICOPTER																						
1. Electrical Arcing																						
2. "Electronic Equipment																						
3. Engine Emissions																						
C. AIRCRAFT OPERATING FLUIDS																						
1. Deterioration (Nonmetals)																						
a. Fiberglass Fairings Deteriorate--Oil, Hyd Fluid	X													3/2.53	1/.41							
b. Cushion Clamps Deteriorate--MIL-L-7800 Oil				X										1/.77								
c. Terminal Nipples Deteriorate--Hyd Fluid																						
d. Seals																						
(1) Ramp, Cargo Door Seal Deteriorate--Hyd Fluid	X													5/7.66								
(2) Actuator, Lower Boost, Teflon Seals Leak														1/.60								
(3) Swashplate Seal Leaks--Oil										X				1/.07								
(4) Tail Rotor Gearbox, Input & Output Seals Leak				X															3/2.28			
(5) Transmission Rotor Shaft Seal Leaks				X								1/.39	1/*		1/*							
e. Walkway Coatings Deteriorate--Oil, Hyd Fluid	X											1/*	1/.37	1/*								
f. Shock Mounts																						
(1) Fuel Pressure Transmitter--Fuel and Oil										X								1/*				
(2) Main Transmission Isolation Mount--Oil				X														1/*				
g. Transmission Sight Gage Discoloration--Oil				X														1/*				
h. Wire Ident Tapes Deteriorate & Fall Off--Fuel, Oil					X													1/*				
i. Rubberized Decals Deteriorate--Oil, Hyd Fluid							X							5/5.28	5/*							
j. FM Antenna, ARC 54, Short Circuits--Oil	X																	1/.05				
k. Gas Producer Control Bellows--Oil, Fuel										X									1/.11			
2. Corrosion (Metals)																						
a. Bearings, Wheel--Water Landings														1/.50								
b. Connectors, Sockets																						
(1) Amphenol Connectors Corrode--Moisture						X						1/*	1/.22						1/*	1/.20		
(2) Anticollision Light Sockets Corrode--Moisture					X																	
c. Control Pollicrank Corrodes in Access Hole--Moisture							X							1/*								
d. Rotor Hubs and Hardware																						
(1) Mounting Bolt, MR Blade Corrodes--Moisture										X		1/*										
(2) Mounting Bolt, TR Blade Corrodes--Moisture										X		1/*										
(3) Rotor Mast, Hub & Scissors Corrodes--Moisture										X				1/*	1/*	1/*	1/*					
e. Airframe Structure and Fittings																						
(1) Airframe Corrosion--Fluids & Debris in Bilges	X											1/*	1/*	1/*	1/*	1/*	1/*	1/*	1/*	1/*		
(2) Tailboom Attaching Fitting--Moisture in Recess	X																			1/*		
(3) Battery Compartment Floor Corrodes--Acid				X																		
f. Switches																						
(1) APP 908 Speed Switch Malfunctions--Moisture						X						1/*										
(2) Oil Pressure Switch Shorted--Moisture										X		1/*										
(3) Transmission Oil Pressure Switch Shorted--Moisture Corrosion										X					1/.11	1/.26						
(4) Hyd Pressure Switch Shorted--Moisture Corrosion										X					1/.32	1/.13						
(5) Hyd Pressure Light Switch Shorted--Moisture Corrosion										X									1/*			
(6) Transmission Oil Pressure Light Switch Shorted--Moisture Corrosion										X									1/*			
g. N ₂ Linear Actuators Inoperative--Moisture Corrosion											X	1/*							1/.12			
h. Magnetic Brakes																						
(1) Thrust Magnetic Brake Will Not Release--Oil Contamination														1/.32								
(2) Lateral Magnetic Brake Binds or Slips--Oil Contamination																			1/.05			
(3) Magnetic Brake Internal Corrosion--Moisture Entry at Shaft																		1/.94				
i. Tail Rotor Driveshafts Corrode Under Bearing Collar				X															1/.69	1/.24		
j. Tachometer Indicators Fail--Moisture Corrosion										X												
k. Cargo Winch Brake Sticks--Hyd Fluid on Discs						X								2/1.73								

*Failure rate unavailable (weight factor is one or equal to a known rate for a similar failure mode).

*Failure rate unavailable (weight factor is one or equal to a known rate for a similar failure mode).

TABLE V - Continued																			
Induced Environmental Factor and Problem Description	System Affected											Helicopter Models							
	Airframe	Comm/Nav	Drive	Electrical	Landing Gear	Equipment	Flight Control	Hydraulics	Indicating	Rotor	Powerplant	CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	OH-6A
Component/Failure Mode/Cause	1	2	3	4	5	6	7	8	9	10	11	Weight Factor/Component Failure Rate							
3. Dirt Contamination																			
a. Bearings																			
(1) Rod End Bearings Worn--Contaminated by Dust										X			3/2.78	3/*					
(2) Main Transmission Oil Cooler Pulley Bearing Worn					X						2/1.69								
(3) Pitch Link Bearings, Main Rotor Worn--Contamination										X				5/5.08					
(4) Pitch Link Bearings, Tail Rotor Worn--Contamination										X	3/2.84			1/.73	1/.73	2/1.43			
(5) Scissors and Sleeve Plain Bearings Worn							X			X				2/1.04	1/.91	1/.32			
(6) Bellcrank Bearings Seize--Corrosion																			
(7) Tail Rotor Control Bearings Rough--Contamination										X									4/4.60
(8) Tail Rotor Hangar Bearing Fails--Contamination										X								4/3.9	
(9) Tail Rotor Trunnion Bearing Worn--Contamination										X								1/.33	
(10) Sleeve Bearing, Swashplate Support Worn--Contamination										X								2/1.58	
(11) Sleeve Bearing, Idler Lever Worn--Contamination							X											4/3.30	
b. Seals																			
(1) Upper Boost Actuator Seal Fails & Causes Leaks							X					1/.53							
(2) Rotor Hub Pitch Housing Inboard Seal Leaks--Contamination										X		2/1.56	2/*						
(3) APP Clutch Bearing Seal Deteriorates--Contamination						X					3/2.93								
(4) Main Rotor Spindle and Sleeve Seal Leaks--Contamination										X	1/*								
(5) Tail Rotor Spindle and Sleeve Seal Leaks--Contamination									X	X	4/4.18								
(6) Servo Cylinder Seal Fails--Contamination							X							2/1.37	2/1.37				
(7) Main Rotor Grip Seal Fails--Contamination and Dirt Enters Bearing										X				2/1.45	2/1.43	4/3.21			
c. Cables Wear at Pulley, Tail Rotor Control--Dirt and Grit							X							3/2.46	3/*	3/2.16			
d. Main Rotor Dynamic Droop Stop Sticks--Contamination										X				5/10.0					
e. Generator Bearing, Brush and Slip Ring Wear					X							2/1.26							
D. CLEANING MATERIAL AND TECHNIQUES																			
1. Windshields Scratched by Improper Washing--Cleaning Methods	X											1/.02	1/.53	1/.54	1/.64				1/*
2. Airframe																			
a. Electrical Panels and Antennas (Lower Fuselage) Corrode--Moisture					X									1/.12					
b. Bonded Honeycomb Panels Deteriorate--Pressure and Steam Wash	X																	1/*	
c. DC Voltage Regulator Inoperative--Washing Technique					X							1/.92	1/*				1/*		
d. Ramp Hinge Fitting Corrodes--Fluids and Debris	X																		
3. Control System Bearings Walking--Beam Bearings Corrode--Water							X					1/*							
4. Engine																			
a. Compressor Discs Corrode--Cleaning Agent (T-53-L-13)										X							1/.39		
b. Inlet Housings Corrode--Water Collection																	1/*		
c. Plastic Linings Erode--Cleaning Agent (T-63 Eng)																	1/.04	1/.04	
E. MECHANICAL SHOCK OF LANDING AND GUST LOADS																			
1. Rotor Blade/Fuselage Contact--Gusts, Downwash										X		1/.012	1/.012						
2. Structural Damage Fuel Post Attaching Fittings Crack--Hard Landings	X											2/1.68							
F. ANIMAL FLUIDS, SECRETION, ETC.																			
Corrosive Effects																			
a. Fuselage Skin and Frames Corrode	X											1/*	1/*						
b. Fuselage Flooring Corrodes	X											1/.12	1/.05						
G. AIRCRAFT TRANSPORT																			
Protection From Elements																			
a. Airframe Corrosion--Sea Transport Cocoon Inadequate	X										1/*								
b. Main Transmission Contamination Water--Air Transport Temp Extremes		X									1/*								
*Failure rate unavailable (weight factor is one or equal to a known rate for a similar failure mode)																			

*Failure rate unavailable (weight factor is one or equal to a known rate for a similar failure mode)

TABLE V - Continued

Induced Environmental Factor and Problem Description	System Affected											Helicopter Models								
	Airframe	Comm/Nav	Drive	Electrical	Landing Gear	Equipment	Flight Control	Hydraulics	Indicating	Rotor	Powerplant	CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	OH-6A	
Component/Failure Mode/Cause	1	2	3	4	5	6	7	8	9	10	11	Weight Factor/Component Failure Rate								
2. Vibratory Load Damage Airframe Damaged--Land Transport	X																		1/*	
H. <u>RODENT DAMAGE</u> Electrical Wiring Damaged, Severed--Rodents				X									1/*	1/*						
I. <u>INTERNAL AIRFLOW PATTERNS</u>																				
1. Reverse Flow in Cockpit																				
a. Radar Altimeter Wiring Short--Smoke in Cockpit		X																10/**		
b. Generator Failure Caused Fire--Smoke in Cockpit(2)			X															20/**		
c. Converter Short Caused Smoke in Cockpit			X															10/**		
d. ARC 55 Blower Motor Failed--Smoke in Cockpit				X														1/*		
e. Dust, Dirt, Debris Blow into Cockpit from Cabin					X															
2. Cooling and Ventilating No Ram Air, Fan, etc., for Cockpit Cooling					X								1/*						1/*	
3. Potential Fire Hazard																				
a. Aft Pylon Fire in Flight--Cause Undetermined (2)	X												20/**							
b. Engine Cross Shaft Fairings--Fire Path to Aft Pylon	X												10/**							
c. Engine Transmission Spewed Oil into Engine Starting Fire (2)													20/**							
d. Hyd Cooler Fan Creates Draft Engine to Aft Pylon						X							10/**							
* Failure rate unavailable **Mission affecting (total weight factor is equal to number of incidents times 10)																				

* Failure rate unavailable

**Mission affecting (total weight factor is equal to number of incidents times 10)

PROBLEM SIGNIFICANCE

After establishing the distribution pattern and weighted failure rates for problems caused by induced environmental factors, the factors having the most significant effect on helicopter reliability must be determined in order to establish a priority for document review.

Table VI presents a matrix of weighted failure rates for all the recorded problems available during this study on all aircraft examined. These values are summed in the Total Weight Factor column to establish a numerical value for each detailed component/failure mode within each induced environmental category. The sum of all weighted failures for each aircraft appears at the bottom of the appropriate column. The weight values for internal airflow patterns are not included in the aircraft totals because they do not represent failure rates, per se, and are heavily weighted for their mission effect. Thus these problems are significant only for effect on the mission and do not relate to the significance of the failure rate. Failure rate significance is summarized in Table VII; here the aggregate significance of environmentally induced failures for each aircraft is indicated as a percentage of the total aircraft failure rate, except where total rates were not available.

It is obvious that problems attributable to the induced environmental factors defined in this study represent a very small proportion (3.6 to 5.5 percent) of total aircraft failures.

TABLE VI. PROBLEM SIGNIFICANCE MATRIX

Induct + Environmental Factor	Total Weight Factor	Failure Mode Weight Factor							
		CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	OH-6
A. TEMPERATURE OR THERMAL SHOCK	(20)								
1. Electronic Compartment	16	1					15		
2. Windshield Anti-icing	2		1						
3. Seal, MR Spindle, and Sleeve	1	1							
4. Seal, MR Blade Grip	1							1	
B. OZONE (O₃) GENERATED BY HELICOPTER	(0)								
1. Electrical Arcing	0								
2. Electronic Components	0								
3. Engine Emissions	0								
C. AIRCRAFT OPERATING FLUIDS	(153)								
1. Deterioration (Nonmetal)	(36)								
a. Fiberglass	1			1					
b. Cushion Clamps	3		3						
c. Terminal Nipples	1		1						
d. Seals	12	1	5,1	1				3	
e. Walkway Coating	3	1	1	1					
f. Shock Mounts	2						1	1	
g. Transmission Sight Gage	1			1					
h. Decals and Identification Tapes	11		5	5,1					
i. FM Antenna	1						1		
j. Gas Producer Control Bellows	1							1	
2. Corrosion (Metal)	(37)								
a. Bearings	1		1						
b. Connectors	4	1	1					1,1	
c. Control Castings	1		1						
d. Hubs and Attaching hardware	5	1,1			1	1	1		
e. Airframe Structure/fittings	9		1	1	1	1	1	1,1	1,1
f. Switches	8	1,1			1,1	1,1		1,1	
g. Actuators	2	1						1	
h. Magnetic Brakes	3		1			1			
i. Driveshafts	1								
j. Indicator, Tachometer	1								
k. Cargo Winch Brake	2		2						
3. Dirt Contamination/Wear	(80)								
a. Bearings	39	2,1	3	3	1,2,5	1,1,1		1,1,1	
b. Seals	25	1,3,4	1,1	2	2,2	2,2			
c. Cables	9				3	3			
d. MR Dynamic Droop Stop	5				5				
e. Generator	1		2						
D. CLEANING MATERIALS AND TECHNIQUES	(15)								
1. Windshields	5		1	1	1	1			
2. Airframe	5		1	1,1					
3. Control System	1		1						
4. Engine Compressor and Blades	4								
E. MECHANICAL SHOCK (LANDING/GUST LOADS)	(4)								
1. Rotor Blade/Fuselage Contact	2		1	1					
2. Structural Damage	2		2						
F. ANIMAL FLUIDS AND SECRECTIONS	(4)								
Corrosive Effects	4		1,1	1,1					
G. AIRCRAFT TRANSPORT (Air, Sea, Land)	(3)								
1. Protection From Elements	2	1,1							
2. Vibratory Load Damage	1								
H. RODENT DAMAGE	(2)								
Electrical Wiring	2								
I. INTERNAL AIRFLOW PATTERNS	(113)*								
1. Cockpit Air Contamination	51		10,10,1	10,20					
2. Cooling/Ventilating	2		1						
3. Potential Fire Hazards	60		20,10						
			20,10						
Total Weight Factor	314	75	42	24	25	6	3	1	1
* Not included in total weight factor for individual aircraft									

TABLE VII. INDUCED ENVIRONMENTAL PROBLEM SIGNIFICANCE SUMMARY								
Summary	CH-54	CH-47	CH-46	UH-1C	UH-1D	AH-1G	OH-58	OH-6A
Number of Failure Modes	17	34	19	12	12	11	22	5
Weighted Induced Environmental Failures per 1,000 Flight Hours	25	42	24	25	16	31	30	8
Total Reported Aircraft Failure per 1,000 Flight Hours	a	1,170 ^b	670 ^c	624 ^d	a	565 ^e	a	a
Percent of Total Reported Failures Caused by Weighted Induced Environmental Factors	-	3.6	3.6	4.0	-	5.5	-	-
a. Failure rate unavailable b. USAAWNTB, Ft. Rucker, Ala., Jun 69 to Sep 70 c. U.S. Navy 3M data, RVN, 1969 d. U.S. Navy 3M data, RVN, Dec 69 to Dec 70 for UH-1E e. U.S. Navy 3M data, RVN Jan 70 to Dec 70								

Figure 2 shows the proportion that each environmental factor contributes to these equipment failures. Further aspects of these results will be discussed later in this report.

Prioritization

The summation of individual weight factors within each induced environmental category is presented in the left-hand column of Table VI. From these data, the bar graph in Figure 3 was constructed to show the relative significance of each induced environmental factor. However, priority of attention to specifications with concern for design and test requirements cannot be related to the significance or priority of the environmental causal factors for the failures involved. Specifications relate to systems, components, and hardware, and therefore prioritization of document review must be based on the relative weight of individual components. Table VIII displays the identified system/component/failure mode problems and the internal airflow problems in individually weighted sequence and without regard for causal factor priority.

Category A, Mission Affecting Problems, contains the two highest weighted individual problem areas. Category B contains the seven highest weighted R&M problems, ranging from weight of 40 for bearings down to 8 for switches. These problems are considered generic or frequent based on the failure pattern from Table VI. The nine category A and B problems represent a weight of 250, or 80 percent of the total weight of 314 shown in Table VIII. These are the systems and components whose design and test specifications will be reviewed and assessed for adequate induced environmental criteria, leaving the remaining 30 low-frequency problems in category C represent a weight of 64, only 20 percent of the total.

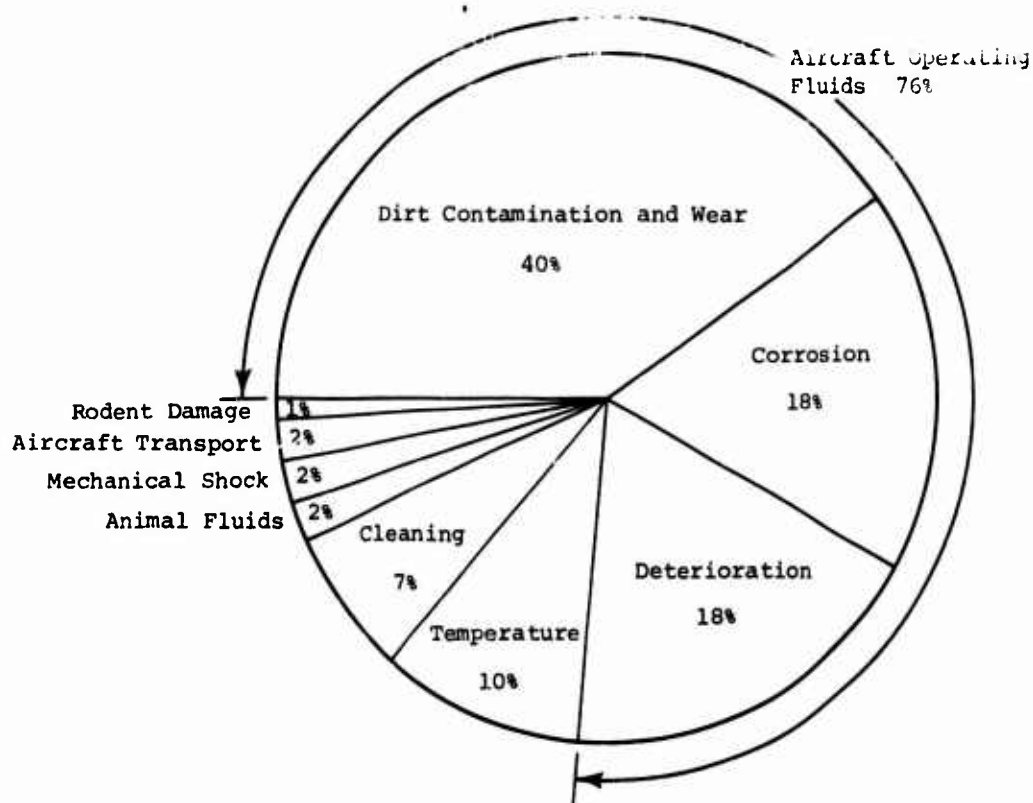


Figure 2. Distribution of Induced Environmental Factors Causing Equipment Failures in Army Helicopters.

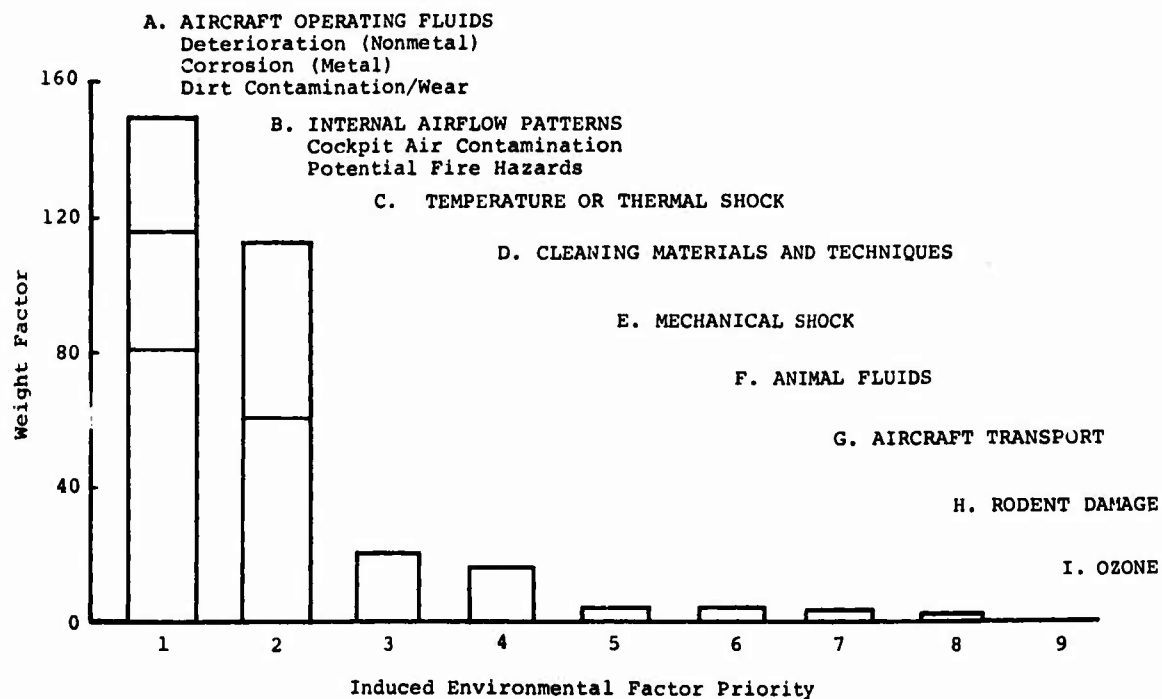


Figure 3. Priority of Induced Environmental Factors.

TABLE VIII. PRIORITY OF INDUCED ENVIRONMENTAL PROBLEMS			
Priority	Item	Problem Weight	Category Weight
Category A Mission Affecting Problems			111
1	Potential Fire Hazards	60	
2	Cockpit Air Contamination	51	
Category B Generic or Frequent R&M Problems			139
3	Bearing Contamination	40	
4	Seal Contamination, Deterioration	37	
5	Airframe Corrosion	18	
	Operating Fluids	(9)	
	Cleaning Materials	(5)	
	Animal Fluids	(4)	
6	Electrical Compartment Heat	16	
7	Decals and Identification Tapes	11	
8	Control Cable Abrasion	9	
9	Switch Corrosion	8	
Category C Low-Frequency R&M Problems			64
10	Hubs and Attaching Hardware - Corrosion	5	
11	Dynamic Droop Stop - Contamination	5	
12	Windshield - Cleaning	5	
13	Connectors - Corrosion	4	
14	Engine Compressor/Blades - Corrosion	4	
15	Walkway Coating - Deterioration	3	
16	Cushion Clamps - Deterioration	3	
17	Magnetic Brakes - Corrosion	3	
18	Protection From Elements - Air Transport	2	
19	Actuators - Corrosion	2	
20	Windshield - Anti-Icing	2	
21	Rotor Blade - Fuselage Contact	2	
22	Structural Damage - Landing Shock	2	
23	Gen Brush, Slip Ring - Contamination	2	
24	Shock Mounts - Deterioration	2	
25	Cargo Winch Brake - Contamination	2	
26	Electrical Wiring - Rodent Damage	2	
27	Cockpit - Cooling and Ventilating	2	
28	Seal, Main Rotor Spindle & Sleeve Leaks/Temp Change	1	
29	Seal, Main Rotor Blade Grip Leaks/20°F	1	
30	Fiberglass - Deterioration/Fluid	1	
31	Terminal Nipples - Deterioration/Fluid	1	
32	Transmission Sight Gauge - Discoloration/Oil	1	
33	FM Antenna - Shorts/Oil	1	
34	Gas Producer Control Bellows -Deterioration/Oil	1	
35	Control Castings - Corrosion	1	
36	Driveshafts - Corrosion	1	
37	Indicator, Tachometer - Corrosion	1	
38	Structural Damage (Land Transport) - Vibration	1	
39	Control System Bearings - Corrosion	1	
Total Weight			314

EFFECTS OF INDUCED ENVIRONMENTAL FACTORS ON NEW DESIGNS

The induced environmental factors defined in this study were reviewed for possible effects on two next-generation Army helicopters currently in the design development stage. This assessment is qualitative only and is based on direct comparison of similar components or systems. Where direct comparison is not possible, analysis is based on projected reliability rates as developed in the new aircraft R&M analysis programs which in most cases are not yet validated by test.

The details of this review are shown in Table IX. The chart briefly states the new design approach to each of the problem areas revealed in the quantitative review of current helicopters. The several instances noted as not applicable are usually qualified by identifying the new design concept which replaced the one displaying the problem. Where no comparable component or configuration exists, the notation so indicates.

The Problem Anticipated column assesses the individual problem against the new design approach.

An overview of the anticipated effect of the induced environmental factors on new designs is presented in Table X; it is a summation of the detailed analysis in Table IX. The aircraft system/subsystem/component induced environmental factors are listed in the order of their significance and their effect is noted as Less, Same, or More. The Rationale column reflects brief justification for the judgemental conclusions in the previous columns.

In essence these conclusions may be stated as follows:

- Most induced environmental factors as defined in this study will have less adverse effect than previously for the reasons noted. For the most adverse induced environmental factor (aircraft operating fluids), the expected improvements result from a combination of better design specifications, improved materials, and inherently less vulnerable designs due to greater awareness of the causal factors on the part of aircraft designers. Less thermal effect is anticipated in electronic compartments because of improved specifications and solid state design concepts. Air conditioning or circulation is expected to greatly reduce cockpit contamination. Cleaning materials are generally adequate, but even with the most explicit instructions, frequency and methods of cleaning are still subject to the human element.

TABLE IX. ANALYSIS OF NEW DESIGNS					
Induced Environmental Factor and Problem Description	Next-Generation Army Helicopters				
	Utility/Assault		Heavy Lift		
	Design Approach	IE Problem Anticipated Yes No	Design Approach	IE Problem Anticipated Yes No	
Component/Failure Mode/Cause					
A. TEMPERATURE OF THERMAL SHOCK					
1. Electrical/Electronic Compartment					
a. AFSS Amplifier Malfunctions--Condensation	Part of SCAS, Temperature Compensated	X	All Avionics Components Sealed		X
b. UHF RT Unit Inoperative--Heat	Louvers Provide Adequate Airflow	X	Avionics Components Pneumatically Cooled		X
c. VHF RT Unit Inoperative--Heat	Louvers Provide Adequate Airflow	X	Avionics Components Pneumatically Cooled		X
d. FM Radio RT Unit Inoperative--Heat	Louvers Provide Adequate Airflow	X	Avionics Components Pneumatically Cooled		X
2. Windshield					
a. Blisters/Anti-Ice Heat to Dry Dew--Fog	Temperature Sensor Control	X	Hot-Air Heat		X
b. Anti-Ice Temp Control Malfunctions Below 0°C	Temperature Sensor Control	X	Hot-Air Heat		X
3. Seal, MR Spindle & Sleeve Leaks--Temp Change	Seal Pressurized to 1/2 Atmosphere	X	Elastomeric Bearings		X
4. Seal, MR Blade Grip Leaks Below 20°F	Seal Pressurized to 1/2 Atmosphere	X	Elastomeric Bearings		X
B. OZONE (O₃) GENERATED BY HELICOPTER					
1. Electrical Arcing	Standard Design Practice		X Standard Design Practice		X
2. Electronic Equipment	Standard Design Practice		X Standard Design Practice		X
3. Engine Emissions	Standard Design Practice		X Standard Design Practice		X
C. AIRCRAFT OPERATING FLUIDS					
1. Deterioration (Nonmetals)					
a. Fiberglass Fairings Deteriorate--Oil, Hyd Fluid	Fiberglass Panels and Nomex Core Doors	X	Nomex Blades, Expanded AL Honeycomb Skin		X
b. Cushion Clamps Deteriorate--MIL-I-7608 Oil	Ty-Rap Bands (MS-3367)		X Ty-Rap Bands (MS-3367)		X
c. Terminal Nipples Deteriorate--Hyd Fluid	Terminal Board & Cover Used		X Terminal Board & Cover Used		X
d. Seal--					
(1) Ramp, Cargo Door Seal Deteriorates--Hyd Fluid	No Sealant Installation		X Cargo Door and Workplatform Seals		X
(2) Actuator, Lower Boost, Teflon Seals Leak	No Lower Boost Installed		X Not Applicable/Fly by Wire		X
(3) Washplate Seal Leaks--Oil	Double-Lip Seal, Grease Tube		X Double-Lip Seal, Grease Tube		X
(4) Tail Rotor Gearbox, Input & Output Seals Leak	Static Oil Head Drain		X No Fly by Wire Installation		X
(5) Transmission Rotor Shaft Seal Leaks	Static Oil Head Drain		X Static Oil Head Drain		X
e. Walkway Coating Deteriorates--Oil, Hyd Fluid	Deck Coating per MIL-D-23003		X Walkways		X
f. Shock Mounts:					
(1) Fuel Pressure Transmitter--Fuel and Oil	No Transmitter Installed		X Engine Mounted		X
(2) Main Transmission Isolation Mount--Oil	Mounts Have Protective Coating	X	Transmissions Not Isolated		X
g. Transmission Sight Gage Discolors--Oil	Cockpit Indicators Used		X Optical Glass in Prototype		X
h. Wire Ident Tapes Deteriorate & Fall Off--Fuel, Oil	Tapes Tied in Fluid Areas		X Tapes Tied in Fluid Areas		X
i. Rubberized Decals Deteriorate--Oil, Hyd Fluid	Clear Lacquer Coating Used		X Clear Lacquer Coating Used		X
j. FM Antenna, ARC 54, Short Circuits--Oil	Antenna Integral in Vertical Stabilizer	X	Not Applicable in Prototype		
k. Gas Producer Control Bellows--Oil, Fuel	Fluorosilicone High Temp Oil-Resistant Material Per MIL-R-25988	X	X Actuator Mounted on Fuel Control		X
2. Corrosion (Metals)					
a. Bearings, Wheel--Water Landings	Sealed Bearings/Water Landings Not Required	X	Water Landings Not Required		X
b. Connectors, Sockets					
(1) Amphenol Connectors Corrode--Moisture	Environmental Connectors		X Environmental, Sealed Connectors		X
(2) Anticollision Light Sockets Corrode--Moisture	Fuselage Drains		X Fuselage Drains		X
c. Control Bellcrank Corrodes in Access Hole--Moisture	Aluminum Bellcranks		X Not Applicable--Fly by Wire		X
d. Rotor Hubs & Hardware:					
(1) Mounting Bolt, MR Blade Corrodes--Moisture	Special Pin With Protective Cover	X	Teflon Bushing With 0.030 Loose Fit Bolt		X
(2) Mounting Bolt, TR Blade Corrodes--Moisture	Special Pin With Protective Cover	X	Teflon Bushing With 0.030 Loose Fit Bolt		X
(3) Rotor Mast, Hub & Scissors Corrodes--Moisture	Titanium Hub		X Titanium Hub		X
e. Airframe Structure & Fittings:					
(1) Airframe Corrosion--Fluids & Debris in Bilges	Fuselage Drains	X	Not Applicable/Cargo External		X
(2) Tailboom Attaching Fitting--Moisture in Recess	Aluminum Fittings--No Recesses	X	No Tailboom		X
(3) Battery Compartment Floor Corrodes--Acid Overflow	Battery Charger Regulated by Temperature Sensor	X	Battery Charger Regulated by Temperature Sensor		X
f. Switches:					
(1) APP 90% Speed Switch Malfunctions--Moisture	Control Assembly in Sealed Box		Design Not Finalized		-
(2) Oil Pressure Switch Shorted--Moisture	Sealed Switches	X	X Sealed Switches		X
(3) Transmission Oil Pressure Switch Shorted--Moisture Corrosion	Welded Switch, Potted Connector	X	Welded Switch, Sealed Connector		X
(4) Hyd Pressure Switch Shorted--Moisture Corrosion	Hermetically Sealed Switches	X	Hermetically Sealed Switches		X
(5) Hyd Pressure Light Switch Shorted--Moisture Corrosion	Hermetically Sealed Switches	X	Hermetically Sealed Switches		X
(6) Transmission Oil Pressure Light Switch Shorted--Moisture Corrosion	Welded Switch, Potted Connector	X	Hermetically Sealed Switches		X
g. N ₂ Linear Actuators Inoperative--Moisture Corrosion	Mechanical Control Only	X	X Electronic Control		X
h. Magnetic Brakes:					
(1) Thrust Magnetic Brake Will Not Release--Oil Contamination	Improved Seals and Cases	X	Not Applicable--Fly by Wire		X
(2) Lateral Magnetic Brake Binds or Slips--Oil Contamination	Improved Seals and Cases	X	Not Applicable--Fly by Wire		X
(3) Magnetic Brake Internal Corrosion--Moisture Entry at Shaft	Improved Seals and Cases	X	Not Applicable--Fly by Wire		X
i. Tail Rotor Driveshafts Corrode Under Bearing Collar	Improved Material Coatings	X	No Equivalent Installation		X
j. Tachometer: Indicators Fail--Moisture Corrosion	Vertical Tape in Sealed Module	X	Vertical Tape in Sealed Module		X
k. Cargo Winch Brake Sticks--Hyd Fluid on Discs	No Cargo Winch Installed	X	X Winch Pneumatically Operated		X

TABLE IX - Continued

		Next-Generation Army Helicopters			
		Utility/Assault		Heavy Lift	
Induced Environmental Factor and Problem Description		Design Approach		Design Approach	
Component Failure Mode/Cause		If Problem Anticipated		If Problem Anticipated	
		Yes	No	Yes	No
C. Dirt Contamination					
a. Bearings					
(1) Rod End Bearings Worn--Contaminated by Dust	Larger Bearings, Teflon Seals	X		Larger Bearings, Teflon Seals	X
(2) Main Transmission Oil Cooler Pulley Bearing Worn	Not Applicable, Integral Lubrication	X		Not Applicable, Integral Lubrication	X
(3) Pitch Link Bearings, Main Rotor Worn--Contamination	Improved TFE Bearings	X		Improved TFE Bearings	X
(4) Pitch Link Bearings, Tail Rotor Worn--Contamination	Improved TFE Bearings	X		Improved TFE Bearings	X
(5) Scissors & Sleeve Plain Bearings Worn	No Equivalent Installation	X		No Equivalent Installation	X
(6) Bellcrank Bearings Seize--Corrosion	Aluminum Bellcranks, Roller Bearings	X		Not Applicable--Fly by Wire	X
(7) Tail Rotor Control Bearings Rough--Contamination	Tail Rotor Bearing Not Exposed	X		No Equivalent Installation	X
(8) Tail Rotor Hanger Bearing Fails--Contamination	Tail Rotor Bearing Not Exposed	X		No Equivalent Installation	X
(9) Tail Rotor Transmission Bearing Worn--Contamination	Not Applicable--Flex Strap	X		No Equivalent Installation	X
(10) Sleeve Bearing, Swashplate Support Worn--Contamination	No Equivalent Installation	X		No Equivalent Installation	X
(11) Sleeve Bearing, Tail Lever Worn--Contamination	Sealed Roller Element Bearings	X		Not Applicable--Fly by Wire	X
b. Seals					
(1) Upper Rotor Actuator Seal Fails & Causes Leaks	Piston Rod, O-Ring, Scraper Combination	X		Double Seals Used	X
(2) Rotor Hub Pitch Housing Inboard Seal Leaks--Contamination	Dust Lip on Seal, Differential Pressure	X		Not Applicable--Elastomeric Bearings	X
(3) APP Clutch Bearing Seal Deteriorates--Contamination	Clutch Bearing Sealed	X		APP in Sealed Compartment	X
(4) Main Rotor Spindle & Sleeve Seal Leaks--Contamination	Dust Lip on Seal, Differential Pressure	X		Not Applicable--Elastomeric Bearing	X
(5) Tail Rotor Spindle & Sleeve Seal Leaks--Contamination	Not Applicable--Flex Strap	X		No Equivalent Installation	X
(6) Servo Cylinder Seal Fails--Contamination	Piston Rod, O-Ring, Scraper Combination	X		Double Seals Used	X
(7) Main Rotor Grip Seal Fails--Contamination & Dirt Enters Bearing	Dust Lip on Seal, Differential Pressure and Hub Cover Used	X		Not Applicable--Elastomeric Bearings	X
c. Cables Wear at Pulley, Tail Rotor Control--Dirt and Grit					
(1) Main Rotor Dynamic Droop Stop Sticks--Contamination	Not Applicable--No Cables Used	X		Not Applicable--No Cables Used	X
d. Generator Bearings, Brush & Slip Ring Wear					
	Brushless, Oil Cooled, Lubed Bearings	X		Brushless, Oil Cooled, Lubed Bearings	X
D. CLEANING MATERIAL & TECHNIQUES					
1. Windshields					
Scratched by Improper Washing--Cleaning Methods	Laminated Windshield, Glass Outer Ply	X		Laminated Windshield, Glass Outer Ply	X
2. Airframe					
a. Electrical Panels & Antennas (Lower Fuselage) Corrode--Moisture	Drainage Provided	X		Drainage Provided	X
b. Bonded Honeycomb Panels Deteriorates--Pressure & Steam Wash	No Protection Against Improper Washing Procedure	X		No Protection Against Improper Washing Procedure	X
c. DC Voltage Regulator Inoperative--Washing Technique	No Protection Against Improper Washing Procedure	X		No Protection Against Improper Washing Procedure	X
d. Ramp Hinge Fitting Corrodes--Fluids & Debris	No Equivalent Installation	X		No Equivalent Installation	X
3. Control System Bearings					
Walking-Bear Bearings Corrode--Water	Bearings have Teflon Seals	X		Not Applicable--Fly by Wire	X
4. Engine					
a. Compressor Discs Corrode--Cleaning Agent (T-53-L-13)	Integral Wash Manifold Limits Procedures and Materials	X		Integral Wash Manifold Limits Procedures and Materials	X
b. Inlet Housings Corrode--Water Collection	Titanium Case, Steel V-Band	X		Design Not Finalized	-
c. Plastic Linings Erode--Cleaning Agent (T-63 Eng)	No Protection Against Improper Washing Procedure	X		No Protection Against Improper Washing Procedure	X
E. MECHANICAL SHOCK OF LANDING AND GUST LOADS					
1. Rotor Blade/Fuselage Contact--Gusts, Downwash	Rigid Rotor System	X		Centrifugal Droop Stops	X
2. Structural Damage					
Fuel Pod Attaching Fittings Crack--Hard Landings	Landing Gear Absorbs Shock Up to 42 fpm Rate of Descent	X		Crashworthy Fuel System	X
F. ANIMAL FLUIDS, SECRETION, ETC.					
Corrosive Effects					
a. Fuselage Skin and Frames Corrode	Corrosion Preventive Coatings	X		No Equivalent Condition	X
b. Fuselage Flooring Corrodes	Fiberglass Covered Nomex Core	X		No Equivalent Configuration	X
G. AIRCRAFT TRANSPORT					
1. Protection From Elements					
a. Airframe Corrosion--Sea Transport Caecoon Inadequate	Not Required by Specification	-		Salt Air Protective Coatings	X
b. Main Transmission Contamination Water--Air Transport Temp Extremes	Sealed Shipping Containers	X		No Production Design to Date	-
2. Vibratory Load Damage					
Airframe Damaged--Land Transport	Landing Gear Tires & Shock Strut	X		Not Applicable to Land Transport	X

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TABLE IX - Continued

Induced Environmental Factor and Problem Description	Next-Generation Army Helicopters			
	Utility Assault	Heavy Lift		IF Problem Antici- pated Yes No
		Design Approach	Design Approach	
Component Failure Mode Cause				
1. DENT DAMAGE				
Electrical wiring damaged, severed--Redents	No Ramp Entry for Redents	X	No Ramp Entry for Redents	X
2. INTERNAL AIRFLOW PATTERNS				
a. Reverse Flow in Cockpit	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
b. Radar Altimeter Wiring Short--Smoke in Cockpit	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
c. Generator Failure Caused Fire--Smoke in Cockpit	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
d. Converter Short Caused Smoke in Cockpit	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
e. APC 55 Blower Motor Failed--Smoke in Cockpit	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
f. Dust, Dirt, Debris Blow into Cockpit from Cabin	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
g. Cooling & Ventilating No Ram Air, Fan Etc., for Cockpit Cooling	Cockpit Ventilation System	X	Cockpit Air Conditioning System	X
3. FIRE HAZARD				
a. Pylon Fire in Flight--Cause Undetermined	Pilot Warning System	X	Engines Sealed from Pylon	X
b. Engine Cross Shaft Fairings--Fire Path to Pylon	Pilot Warning System	X	Engines Sealed from Pylon	X
c. Engine Transmission Speed Oil into Engine Starting Fire	Engine Sealed from Transmission	X	Engines Sealed from Transmission	X
d. Hyd Cooler Fan Creates Draft Engine to Aft Pylon	Backheads Separate Cooling Fan & Pump from Engine Transmission	X	Cooling Air Ducts in Both Pylons Isolated from Engine and Transmission	X

TABLE X. EFFECT OF INDUCED ENVIRONMENT ON NEW DESIGNS				
Induced Environmental Factor/Problem	Effect			Rationale
	Less	Same	More	
A. Aircraft Operating Fluids				
1. Composite Structures			x	Higher percent composites
2. Rubber/Elastomer Components			x	Higher percent elastomers
3. Metal Structures	x			Improved materials and state of the art
4. Bearings	x			Improved materials and state of the art
5. Seals	x			Improved materials and state of the art
6. Switches	x			Better specifications
7. Cables	x			Fewer cables in use
8. Decals and Identification Tapes	x			Better protection procedures and improved tapes
B. Internal Airflow Patterns				
1. Cockpit Contamination	x			Air conditioning requirements
2. Potential Fire Hazards		x		Insufficient data for decision
C. Temperature or Thermal Shock				
1. Electrical/Electronics Compartment	x			Improved specifications and solid-state design
2. Engine Compartment		x		Higher power and temperature but better materials
3. Seals	x			Improved materials
D. Cleaning Materials and Techniques				
1. Windshields	x			Glass surface reduces scratch potential
2. Airframe		x		Maintenance requirement subject to personnel limitations
3. Engines	x			Integral wash manifolds
E. Mechanical Shock/Landing, Gust Loads	x			Improved Ldg Gear & Rotor Design
F. Animal Fluids	x			Limited to cargo modules or medevac missions
G. Aircraft Transport	x			Larger transport aircraft reduce disassembly requirements and damage potential
H. Rodent Damage	x			Affects aircraft with ramps only
I. Ozone Generated by Helicopter		x		No problem indicated
Sunlight/Pollution Effect			x	Elastomeric bearings
Total	15	4	3	

- Problems are classified as having no change in effect either because there is an equal trade-off of good and bad conditions, as in the engine compartment heat problem, or because there is insufficient data for a clear cut decision, as in the case of potential fire hazards.
- The few factors which are anticipated to have a greater effect than in the past are those involving relatively unknown effects such as ozone/sunlight and fluids on the elastomeric applications coming into wider use. To date there is no available protective material which will prevent ozone or sunlight from making rubber brittle without inherent detrimental effect, and there is little or no data from test or experience to enable valid reliability prediction.
- Composite structures have proven their value in strength/weight tests and will receive much wider application in next-generation helicopters. While the greater use of composites may contribute to the reduced effect of fluids on metal structures, it will certainly present the potential for more significant composite structure deterioration than that experienced to date from various fluid effects. Even improved materials and processes in composite manufacture may be inadequate to offset the greater potential for operational and maintenance damage which leaves the composite structure susceptible to fluid incursion.

DOCUMENTATION REVIEW

This section presents the philosophy, criteria, and results of the analysis of military specifications pertaining to the helicopter systems, components, and procedures affected by induced environmental factors. The pertinent documents were identified for those items prioritized in categories A and B, which represent mission-affecting and generic or high-frequency failure rate problems. They were reviewed and assessed with primary concern for deficiencies which could adversely affect safety, reliability, or maintainability as a result of ignorance of or inattention to the induced environmental factors in design and test requirements.

DOCUMENT DEFICIENCY CRITERIA

The criteria used to identify deficiencies in these documents were established by analyzing and defining the specific requirements that must be considered by the designer to meet or exceed the operational parameters of U.S. Army helicopters.

The two general areas in which criteria for induced environment, safety, reliability, and maintainability are of paramount concern are design requirements and test requirements (qualification and demonstration). All documents were reviewed against both of these guidelines unless one or the other was not applicable; in the few cases where one requirement was inapplicable, it was so noted.

General Philosophy

Review of the following paragraphs will reveal repeated use of the term system specification as applied in review criteria and throughout the document revision recommendations. The reason for this is that the system specification is the procuring agency's initial definitive specification for the specific weapon system, which subsequently becomes the contractually binding development specification. Subordinate specifications must be adequate to support the system specification, but not restrict it in any manner since it is the sole vehicle for identification of the operational performance and R&M requirements (which dictate the design and test philosophies) for the weapon system. The system specification must invoke appropriate and necessary subsystem and component specifications to assure that basic requirements are met; but at the same time it must stipulate the special requirements of the particular weapon system, which may then limit, expand, or otherwise modify the supporting specifications.

The general philosophy of the document reviews presented in this study is to support the above concept by clarifying whenever possible the often confusing terms used to identify specifications. Specifications are classified and defined in MIL-STD-490.

Design Requirements

The specific criteria used to analyze each document relative to design requirements are as follows:

Scope

The scope of the specification must provide the designer with the types of applications for which the system, equipment, or component is intended. For example, if the specification is intended to apply only to ground-based applications, the specified operational limitations and design requirements may be inadequate for helicopters. This could result in the premature failure of the component because its operational parameters have been exceeded by use in the helicopter environment. On the other hand, if the specification is intended for missile application, the design requirements may impose more than adequate reliability demands, but the maintenance considerations may be inappropriate for Army field use.

Performance

As with the scope, design and test requirements must ensure that the operational requirements of the Army are considered by the designer. Listing of arbitrary performance parameters is not adequate unless these parameters are consistent with the overall operation and maintenance requirements as defined in the system specification. A component or subsystem can be built to meet or exceed the specification performance requirements and fail to meet the operational reliability or maintainability requirements.

Environmental Conditions

Stresses such as thermal shock, soil particle abrasion, and moisture corrosion resulting from induced as well as natural environmental factors can cause malfunctions or failures unless they are considered in detail design. The environmental conditions in which the system will function must be well defined in system or development specifications (reflecting natural or induced origin), but this distinction in subordinate military specifications would be too detailed and possibly restrictive. Detail design requirements must reflect environmental conditions from the system specification.

Safety

Safety is mandatory with respect to personnel and equipment. Equipment designed without consideration for the safety of the operator, maintenance personnel, and other components of the subsystem or related subsystems could adversely affect the availability, reliability, or maintainability of the system. Poor safety features may necessitate increased precautions during maintenance, thus leading to lower availability. Safety requirements are to be implemented in accordance with MIL-STD-882 and the system specification.

Reliability

Detailed component reliability requirements specified quantitatively in mean time between failures (MTBF) are considered to be as inadequate as no requirement at all. An adequate reliability requirement must be integrated with all other components and systems and based on the projected mission requirements of the helicopter as defined in the system specification. Items designed to an isolated MTBF value stated in a military specification may adversely affect the overall helicopter or system reliability unless they are recognized as part of an overall reliability program to be implemented in accordance with MIL-STD-785 and the system specification.

Maintainability

Maintainability requirements must be stated with reference to the overall helicopter or system availability requirements. Consideration must also be given to U.S. Army maintenance concepts, procedures, and practices. If these parameters are not considered in the overall maintainability plan per MIL-STD-470 and the system specification, the item may not be compatible with the Army system and the helicopter availability and maintenance rates may be adversely affected.

Qualification Test Requirements

The criteria used in the analysis of documents for testing requirements are as follows:

Qualification Test Plan

A qualification test plan is required to ensure that the component meets or exceeds the design requirements imposed by the system and detail design specifications.

Environmental Testing

The equipment should be adequately tested in its intended environment in accordance with the procedures delineated in MIL-STD-810 or MIL-STD-202 and the system specification. Effective simulation of the environmental conditions (such as temperature, sand, and moisture) while operating the component through a representative number of cycles should help to identify inherent design weaknesses prior to production.

Flight Test

Major subsystems and components, such as flight control servocylinders, should undergo testing that is representative of combined flight and environmental conditions to ensure that the system will not fail due to inadequate design for mission requirements.

Service Test

Service testing is a requirement that should be imposed at the system and major component level. This test should include reliability and maintainability demonstrations designed to identify system components that may require maintenance procedures different from those delineated in AR 750-1, ARMY MATERIAL MAINTENANCE CONCEPTS AND POLICIES, dated May 1972, or the system specification.

Documentation Gaps

A document deficiency is considered to exist in any instance where a generic class of equipment is not covered by appropriate specifications or standards defining design or test requirements.

DOCUMENT ANALYSIS AND CLASSIFICATION

The documents applicable to the nine problem areas prioritized as categories A and B were analyzed using the criteria and philosophy described on the preceding pages. The determining factor for selection of applicable documents was the hardware item, its configuration, its application, and its relationship to a system or subsystem. The only deviation from this approach was the review of fire hazards and air contamination, where documentation included design guides and specifications for measuring and controlling air contaminants in addition to certain related hardware definitions.

The full range of documents from system to detail part level as applicable to each particular problem item was reviewed for

design and test requirements. For example, the problem of bearing wear due to contamination or corrosion entered the review of 17 documents ranging from design, installation, test or control systems to definitive detail specifications for a variety of applicable bearing configurations.

Each document was reviewed and coded in one of the following classifications:

- Class A--Adequate: The document meets the established criteria in its present form, and there are no recommendations for revision.
- Class B--Inadequate: The document does not meet the established criteria in its present form, and specific recommendations are made for revisions to correct the inadequacy.
- Class C--Not Applicable: The document has been canceled, superseded, or is not applicable in scope and purpose to the equipment involved.

DOCUMENT REVIEW SUMMARY

As previously noted, the priority for document review is based on the relative significance of system or component failure rates or on the effect of the mission on the helicopter. These top priority problem items and the number and classification of their related documents are summarized in Table XI. The detailed document reviews are contained in Appendices I through III, which are sequenced according to the priority of the induced environmental factors; they therefore do not maintain the same sequential relationship as the problem items. Table XI lists the problems and the appendix in which each is contained. Note that, although a total of 115 reviews were conducted, only 91 documents were involved since a number of documents were reviewed for more than one application. As a ready reference for document application, Table XII lists all documents in numerical order, sequenced according to the priority in Appendix VI. Their applicability is shown by the code entry for each document in the appropriate appendix and group column.

The document review revealed no deficiencies which could not be adequately resolved by revisions. Therefore, there are no recommendations for new documents.

TABLE XI. DOCUMENT REVIEW SUMMARY

Weight Priority	Problem	Number of Documents Reviewed	Rating Code*			Appendix
			A	B	C	
1	Fire Hazards	8	5	3		II (A)
	Cockpit Air Contamination	6	5	1		II (B)
	Bearings	17	0	14	3	I (A-1)
4	Seals	20	4	14	2	I (A-2)
5	Airframe Corrosion	8	8	0		I (B-1)
6	Electronic Compartment	15	5	10		III
7	Decal and Identification Tape	18	2	9	7	I (C)
8	Control Cables	10	5	5		I (A-3)
9	Switch Corrosion	13	3	10		I (B-2)
	Total Reviews**	115	37	66	12	
	Total Documents	91	27	52	12	
*A--Adequate B--Inadequate C--Not Applicable **Total numbers shown are higher than actual number of documents reviewed since some are applicable to more than one problem; see document application chart, Table XII.						

To clarify the relationship between the priority of significant individual problems and the priority of the related induced environmental factors, Table XIII presents this structure as it appears in Appendixes I through V.

TABLE XII. DOCUMENT APPLICATION AND RATING SUMMARY*

Document Number		Appendix Number (Group Letter)							
		I	I	I	I	I	II	II	III
		(A-1)	(A-2)	(A-3)	(B-1)	(B-2)	(C)	(A)	(B)
1	MIL-W-1511			B		B			
2	MIL-S-3786					B			
3	MIL-S-3950					B			
4	MIL-B-3990	B			A				
5	MIL-S-5002		B						
6	MIL-S-5049						B		
7	MIL-W-5088						B		
8	MIL-E-5272	C				B	B		
9	MIL-E-5400					B			B
10	MIL-T-5422					A			A
11	MIL-B-5423					B			
12	MIL-W-5424			B					
13	MIL-H-5440		B						
14	MIL-C-5503		B						
15	MIL-G-5514		A						
16	MIL-P-5516		A						
17	MIL-P-5518		B						
18	MIL-T-5522		B						
19	MIL-B-5628	C							
20	MIL-B-5629	C							
21	MIL-B-5687	B							
22	MIL-T-5955		B						
23	MIL-B-6038	B							
24	MIL-B-6039	B							
25	MIL-W-6729				A				
26	MIL-S-6807					B			
27	MIL-E-7080					B	B		B
28	MIL-F-7179			A	A				
29	MIL-C-7439				A				
30	MIL-R-7575				A				
31	MIL-F-7872						B		
32	MIL-B-7949	B							
33	MIL-P-8564		B						
34	MIL-D-8634						C		
35	MIL-D-8635						C		
36	MIL-T-8679		B						
37	MIL-I-8700					B	B		B
38	MIL-H-8775		B						
39	MIL-R-8791		A						
40	MIL-S-8805					B			

*A--Adequate B--Inadequate C--Not Applicable

TABLE XII - Continued									
Document Number	Appendix Number (Group Letter)								
	I	I	I	I	I	I	II	II	III
	(A-1)	(A-2)	(A-3)	(B-1)	(B-2)	(C)	(A)	(B)	
41 MIL-H-8890		C							
42 MIL-H-8891		C							
43 MIL-B-8942	B								
44 MIL-B-8948	B								
45 MIL-R-9300				A					
46 MIL-S-9395					B				
47 MIL-F-9490	B	B	A						
48 MIL-T-9906						A			
49 MIL-C-11796			A						
50 MIL-C-16173			A						
51 MIL-C-18244		B							
52 MIL-F-18264				A					
53 MIL-H-18325								B	
54 MIL-F-18372	B	B							
55 MIL-C-18375								A	
56 MIL-T-18606									
57 MIL-E-22285							B		
58 MIL-T-23103									A
59 MIL-F-23447							B		
60 MIL-P-25732		A							
61 MIL-P-38477						B			
62 MIL-M-43719						B			
63 MIL-B-81819	B								
64 MIL-B-81820	B								
65 MIL-STD-108									A
66 MIL-STD-202					A				A
67 MIL-STD-454					B	B			B
68 MIL-STD-681						C			
69 MIL-STD-800								A	
70 MIL-STD-810	B	B							
71 MIL-STD-882							A	A	
72 MIL-STD-1132					A				
73 MIL-STD-1247						A			
74 L-T-90						C			
75 L-T-99						C			
76 L-T-100						B			
77 FF-B-185	B								
78 PPP-T-60						C			
79 PPP-T-66						C			
80 MIL-HDBK-221							A		
A--Adequate B--Inadequate C--Not Applicable									

TABLE XII - Continued

Document Number	Appendix Number (Group Letter)								
	I	I	I	I	I	I	II	II	III
	(A-1)	(A-2)	(A-3)	(B-1)	(B-2)	(C)	(A)	(B)	
81 TM55-1500-204-25/1			A	A		B			
82 AMCP 706-203	B	B	B				A	A	A
83 AFSC DH1-X							A		
84 AFSC DH1-6							A		
85 SCL-I-0019									B
86 SCL-I-0020									B
87 SCL-I-0053									B
88 SCL-T-0019									B
89 SCL-T-0020									B
90 SCL-T-0053									B
91 USAF Spec Bulletin 526a								A	
Total	17	20	10	8	13	18	8	6	15
A--Adequate B--Inadequate C--Not Applicable									

TABLE XIII. PROBLEM PRIORITY AND WEIGHT FACTORS

Appendix	Weight Factor
I. Aircraft Operating Fluids	(153)
A. Dirt Contamination/Wear	
1. Bearings	40
2. Seals	25
3. Control Cables	9
B. Corrosion (Metal)	
1. Airframe	13
2. Switches	8
C. Deterioration (Nonmetal)	
1. Decals and Identification Tapes	11
2. Seals (Reviewed in I A-2)	12
II. Internal Airflow Patterns	(113)
A. Potential Fire Hazards	60
B. Cockpit Air Contamination	51
III. Temperature or Thermal Shock	(20)
Electrical/Electronic Compartment	16
IV. Cleaning Materials and Techniques	(15)
A. Airframe Corrosion (Reviewed in I B-1)	5
B. Windshields (Reviewed in I B-1)	5
C. Engines (Reviewed in I B-1)	4
V. Animal Fluids and Secretions	(4)
Corrosive Effects (Reviewed in I B-1)	4

In most cases, the individual problem weight factors do not add up to the total shown for each parent induced environmental factor because the low-priority items are not included in the document review. Further, detailed document reviews are contained only in Appendixes I, II, and III, since the individual problems of Appendixes IV and V are covered in the appropriate documents of Appendix I as noted.

CONCLUSIONS

The following conclusions were reached as a result of this study:

1. The induced environmental factors defined in this study are quantitatively shown to contribute approximately 5 percent of the total aircraft component failure rate. However, two data deficiencies found in this study point to the probability that this contribution could be significantly higher:

- Data shortcomings often make it necessary to exclude certain failures for lack of qualitative causal information.
- The very nature of some environmental conditions makes it difficult to distinguish between natural and induced causal factors, again requiring exclusion of failures due to lack of positive causal identification.

Assessment of the reported failures which were excluded because of these data deficiencies indicates that they comprise a quantitative total rate which could be as large as that which is identified with induced environmental causes. Thus the actual contribution of the induced environment is at least 10 percent of the total aircraft failure rate.

2. Four of the nine induced environmental factors studied are responsible for 95 percent of the induced environmental failures. One of the four, aircraft operating fluids, accounts for 76 percent of the induced environmental failures; and its major subgroup, soil particle contamination, represents 40 percent of all induced environmental failures.
3. On the basis of the study of two next-generation helicopters currently in the design stages, the effects of induced environment are expected to be generally less significant in approximately 68 percent of the problem areas, while 14 percent have the potential for greater effect. State-of-the-art advances in design concepts, materials, and manufacturing processes are largely responsible for those improvements. However, more comprehensive and definitive system and development specifications are also instrumental in assuring that quantitative and qualitative R&M requirements are identified within the framework of anticipated environmental conditions.
4. Approximately two-thirds of the pertinent Military or Government product and detail specifications, standards, and design guides reviewed in this study are deficient to some degree in design, installation, or test requirements when measured against criteria as defined in this analysis.

Recommendations for revision of the deficient documents are presented even though the induced environmental factors defined in this study showed marginally significant effects on the aircraft failure rate. The document revisions encompass all environmental effects which were shown early in this report to include additional induced factors not studied herein (see Figure 1), as well as the entire spectrum of natural environmental factors. Certain of these factors, such as vibration, temperature, and moisture, have been shown in recent studies to have highly significant R&M effects.^{4, 5} Considering the collective environmental effect, the document revisions as recommended in Appendixes I, II, and III are considered justified.

5. The document review revealed no deficiencies which could not be adequately resolved by revisions; therefore, there are no recommendations for new documents.
6. Apart from the problem of adequate design and test criteria in specifications, standards, and design guides, there are several other significant aspects of the specification system which are not conducive to effective application:
 - No distinct or recognizable tree structure;
 - Many redundant and conflicting Army, Navy, and USAF documents;
 - Specification content or application is not clearly identified by an orderly title or numbering system; and
 - Specifications proliferate at such a rapid rate as to form a vast maze too complex for the average designer to penetrate.

Design guides present a possible solution to some of these problems. The identification of preferred specifications and a system-oriented tree structure could be a valuable function of such guides as the Army Engineering Design Handbook series (AMCP 706-200). This three-part series presents a concept for technical guidance of helicopter designers. Parts One and Two, covering preliminary and detail design, are as yet unreleased and could not be evaluated. Part three, QUALIFICATION ASSURANCE, has minor deficiencies as defined in this study. These deficiencies may be representative of a major problem not yet fully recognized, the need for an effective revision system. The document however is considered to be comprehensive in content and effective in its intended purpose, the establishment of airworthiness requirement guidelines.

7. While adequate up-to-date design guides, specifications, and standards are essential in the helicopter design and test process, they alone cannot solve the problem of inadequate consideration of environmental effects. Two additional factors are considered significant in the overall design process:

- The level of technical knowledge of environmental stresses and effects, and
- The requirement for design trade-offs against such inevitably competing factors as cost, schedule, weight, and performance.

The quantitative influence of these factors is not clear, and further study is required to understand their full significance.

RECOMMENDATIONS

The foregoing conclusions suggest several areas for further action:

1. The 52 documents classified as deficient should be revised as recommended in Appendixes I, II, and III.
2. Volumes I and II (AMCP 706-201 and -202) of the U.S. Army Engineering Design Handbook series should be released as soon as possible. A system for revision of these documents should be developed in order to assure that they can be kept up to date and permit ready incorporation of additional material.
3. Army R&D efforts should continue to be directed toward a more comprehensive qualitative and quantitative understanding of environmental stresses both natural and induced. Serious consideration should be given to consolidating this knowledge in a specialized environmental design guide which would provide design and test personnel with the following:
 - A single source of data to aid the designer in recognizing and understanding the effects of environmental conditions on the performance of his equipment,
 - Detailed knowledge of environmental stresses such that design allowables can be established and tests planned to verify adequate reliability and safety margins, and
 - Organized reference to appropriate Government specifications and standards.
4. Procuring agencies should continue to emphasize environmental requirements by providing better definition in system and development specifications. Waivers or deviations should be avoided unless there is positive indication that R&M will not be degraded.

Army R&D efforts should be directed toward a study of the problem of design trade-offs and their significance in the army aircraft development design process.

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GLOSSARY

DEFINITION OF TERMS

AVAILABILITY--A measure of the degree to which an item is in the operable and committable state at the start of the mission when the mission is called for at an unknown (random) point in time

DEMONSTRATED--That which has been proven by the use of concrete evidence gathered under specified conditions

FAILURE--The inability of an item to perform within previously specified limits

FAILURE RATE--The number of failures of an item per unit measure of life (cycles, time, miles, events, etc., as applicable for the item)

INHERENT--Achievable under ideal conditions, generally derived by analysis, and potentially present in the design

MAINTAINABILITY--A characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when the maintenance is performed in accordance with prescribed procedures and resources

MAINTENANCE--All actions necessary for retaining an item in or restoring it to a specified condition

MAINTENANCE MAN-HOURS PER FLIGHT HOUR--The number of maintenance hours expended per flight hour to keep the helicopter flying

MEAN TIME BETWEEN FAILURES (MTBF)--For a particular interval, the total functioning life of a population of an item divided by the total number of failures within the population during the measurement interval; the definition holds for time, cycles, miles, events, or other measures of life units.

MEAN TIME TO REPAIR (MTTR)--The total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time

RELIABILITY--The probability that an item will perform its intended function for a specified interval under stated conditions

SAFETY--The conservation of human life and its effectiveness, and the prevention of damage to items, consistent with mission requirements

DEFINITION OF SPECIFICATIONS

SPECIFICATION--A document intended primarily for use in procurement, which clearly and accurately describes the essential technical requirements for items, materials or services including the procedures by which it will be determined that the requirements have been met. (DOD Directive 4120.3)

GENERAL SPECIFICATION--A document which covers the requirements common to different types, classes, grades and/or styles of items or services

DETAIL SPECIFICATION--A document which covers (either within itself or by referencing and supplementing a general specification) the complete requirements for only one type of item, or for a limited number of types, classes, etc., of similar characteristics

SYSTEM SPECIFICATION--A document which states the technical and mission requirements for a system as an entity, allocates requirements to functional areas (or configuration items), and defines the interfaces between or among the functional areas

DEVELOPMENT SPECIFICATION--A document applicable to an item below the system level which states performance, interface and other technical requirements in sufficient detail to permit design, engineering for service use, and evaluation.

PRODUCT SPECIFICATION--A document applicable to a production item below the system level which states item characteristics in a manner suitable for procurement, production and acceptance.

DIRT CONTAMINATION AND WEAR

Bearings

GROUP: A-1

PROBLEM: Contamination and wear of bearing

TABLE XIV. SPECIFICATION REVIEW SUMMARY--BEARINGS					
Specification			Adequacy*		
Number	Title		A	B	C
1	MIL-F-9490C (USAF) 9 Mar 66	General Specification for Design, Installation, and Test of Piloted Aircraft Flight Control Systems		x	
2	MIL-F-18372 (AER) 31 Mar 55	General Specification for Design, Installation, and Test of Aircraft Flight Control Systems		x	
3	MIL-B-5628 26 Jul 51	Airframe Plain Bearings			x
4	MIL-B-5629 28 Feb 50	Airframe Plain Rod-End AN943, AN947, and AN949 Bearings			x
5	MIL-B-8942 (ASG) 14 Aug 67	Self-Aligning TFE-Lined Plain Bearings (-65°F to +250°F)		x	
6	MIL-B-8948A 30 Nov 72	Self-Aligning TFE-Lined Rod-End Plain Bearings (-65°F to +250°F)		x	
7	MIL-B-81819 (Proposed) Draft 4 Oct 73	High-Speed Self-Aligning Self-Lubricating Plain Bearings (-65° to +160°F)		x	
8	MIL-B-81820A 31 Mar 72	Low-Speed Self-Aligning Self-Lubricating Plain Bearings (-65° to +325°F)		x	
9	MIL-B-6038A 28 Mar 61	Airframe Antifriction Bellcrank Ball Bearings		x	
*A--Adequate B--Inadequate C--Not Applicable					

TABLE XIV - Continued			Adequacy		
Specification			A	B	C
Number	Title				
10	MIL-B-6039C 7 Jul 71	Self-Aligning Antifriction Sealed Rod-End Double-Row Ball Bearings	X		
11	MIL-B-7949D 8 Dec 71	Airframe Antifriction Ball Bearings	X		
12	MIL-B-3990B 11 Dec 68	Airframe Antifriction Needle Roller Bearings	X		
13	MIL-B-5687C 12 Jun 62	Oil-Impregnated Sintered Metal Powder Sleeve Bearings and Thrust Washers	X		
14	FF-B-185 26 Dec 63	Cylindrical Roller Bearings and Self-Aligning Roller Bearings	X		
15	AMCP 706-203 Apr 72	Engineering Design Handbook-- Helicopter Engineering, Part Three, Qualification Assurance	X		
16	MIL-E-5272C (ASG) 22 Jan 71	General Specification for Environmental Testing of Aeronautical and Associated Equipment	X		
17	MIL-STD-810B 21 Sep 70	Environmental Test Methods-- Method 510, Dust	X		
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: MIL-F-9490C (USAF) (9 Mar 66)

1

TITLE: General Specification for Design,
Installation, and Test of Piloted
Aircraft Flight Control Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for design, installation, and test of the operating mechanism of all flight control systems for USAF piloted aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: Requirement inadequately specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

Bearings: TFE-lined spherical bearings not specified

TEST REQUIREMENTS

Reliability: Demonstration requirements specified in paragraph 4.1.3.2 per MIL-R-26667 apply only to electronic equipment

Maintainability: No demonstration requirement specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, add:

MIL-B-8942 Bearings, Plain, TFE-Lined, Self-Aligning

MIL-B-8948 Bearings, Plain, Rod End, TFE-Lined,
Self-Aligning

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.2.1.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.2.6.1--Delete the existing paragraph and add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1--Delete the last sentence and replace it with the following:

Reliability. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.2.6--Add the following to the existing paragraph:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

Paragraph 3.3.2.2--Add the following to the existing paragraph:

Spherical Bearings. Self-lubricating spherical bearings shall conform to MIL-B-8942 or MIL-B-8948.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.1.3.2--Delete the existing paragraph and add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specification For Design,
Installation, and Test of Aircraft
Flight Control Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for design, installation, and test of flight control systems for all types of piloted aircraft contracted for by the U.S. Navy. It is also identified as a controlling specification for U.S. Army helicopters in AMCP 706-203. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No Requirements specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

Bearings: TFE-lined spherical bearings not specified

TEST REQUIREMENTS

Environmental: No Requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, add:

MIL-B-8942 Bearings, Plain, TFE-Lined, Self-Aligning

MIL-B-8948 Bearings, Plain, Rod-End, TFE-Lined,
Self-Aligning

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.1.1.1.3--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.1.1.1.4--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1.1.1.5--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.1.1.1.6--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

Paragraph 3.1.1.12.2--Add the following to the existing paragraph:

Spherical Bearings. Self-lubricating spherical bearings shall conform to MIL-B-8942 or MIL-B-8948.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 3.5.1.4--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.5.1.5--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

GENERAL RECOMMENDATIONS

This specification is considered inferior to MIL-F-9490, even with the above additions, for application to U.S. Army helicopter design and test. It is therefore recommended that in all appropriate specifications (such as AMCP-706-203) reference to MIL-F-18372 be deleted and replaced by MIL-F-9490.

NUMBER: MIL-B-5628 (26 Jul 51)

3

TITLE: Airframe Plain Bearings

C--Not Applicable

EVALUATION COMMENTS

This specification has been cancelled with no superseding standard for airframe self-aligning plain annular bearings AN942. These bearings are not suitable for use in any application.

Personnel safety may be involved.

RECOMMENDATIONS: None

NUMBER: MIL-B-5629 (28 Feb 50)

4

TITLE: Airframe Plain Rod-End Bearings C--Not Applicable

EVALUATION COMMENTS

This specification establishes requirements for the following bearings which have been classified as noted:

AN943 and AN947--Inactive for design after 14 May 1971 with no superseding standard

AN949--Cancelled after 18 February 1971 with no superseding standard

RECOMMENDATIONS: None

TITLE: Self-Aligning TFE-Lined Plain Bearings B--Inadequate

EVALUATION COMMENTS

This specification covers plain spherical bearings, self-aligning and self-lubricating with TFE lining between ball and outer ring for use in -65°F to +250°F range. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Safety: No requirements specified
Reliability: Requirements inadequately specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

- MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)
- MIL-STD-785 Reliability Program for System and Equipment Development and Production
- MIL-STD-810 Environmental Test Methods
- MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements For

Paragraph 3.5.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.3--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.4--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.4--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.5--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Self-Aligning TFE-Lined Rod-End Plain Bearings B--Inadequate

EVALUATION COMMENTS

This specification covers plain rod-end bearings, self-aligning and self-lubricating with TFE lining between ball and outer ring for use in -65°F to +250°F temperature range. Bearing shall contain a bearing cartridge per MS21230 qualified to MIL-B-8942. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environment: No requirements specified
Safety: No requirements specified
Reliability: No requirements specified
Maintainability: No requirements specified

TEST REQUIREMENTS

Environmental: No requirement specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

- MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)
- MIL-STD-785 Reliability Program for System and Equipment Development and Production
- MIL-STD-810 Environmental Test Methods
- MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements For

Paragraph 3.3.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.3--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.4--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.6.7--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.6.8--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-B-81819 (Proposed)
(Draft #4 Oct 73)

7

TITLE: High-Speed Self-Aligning Self-
Lubricating Plain Bearings

B--Inadequate

EVALUATION COMMENTS

This specification covers requirements for sliding spherical bearings which are self-aligning and self-lubricating for use in the -65°F to +160°F temperature range. These bearings are intended primarily for critical applications of low loads and high-frequency oscillation found in helicopters. While the current draft of this document contains some deficiencies, it is recommended as the preferred plain self-lubricating bearing specification for helicopter application. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Safety: No requirement specified
Reliability: Requirements inadequately specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470	Maintainability Program Requirements (For Systems and Equipment)
MIL-STD-785	Reliability Program for System and Equipment Development and Production
MIL-STD-810	Environmental Test Methods
MIL-STD-882	System Safety Program for Systems and Associated Subsystems and Equipment, Requirements For

Paragraph 3.3.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.3--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.4--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.6.5.2--Add the following:

Combined Fluid and Solid Contaminant. Five bearings shall be tested in accordance with 4.6.3 after fluid immersion per 4.6.5 (one bearing in each fluid) except that test bearings will be dusted once per hour of test time with Arizona Road Dust without water contamination.

Paragraph 4.3.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-B-81820A (31 Mar 72)

C

TITLE: Low-Speed Self-Aligning Self-
Lubricating Plain Bearings

B--Inadequate

EVALUATION COMMENTS

This specification covers requirements for plain spherical bearings, self-aligning and self-lubricating with TFE in a liner between the ball and outer ring for use in -65°F to +325°F temperature range. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements are inadequately specified
Safety: No requirement specified
Reliability: Requirements are inadequately specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

- MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)
- MIL-STD-785 Reliability Program for System and Equipment Development and Production
- MIL-STD-810 Environmental Test Methods
- MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements for

Paragraph 3.3.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the detailed specification of the system specification of the procuring agency.

Paragraph 3.3.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.3--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.4--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.5--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.6--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-B-6038A (28 Mar 61)

TITLE: Airframe Antifriction Bellcrank Ball Bearings B--Inadequate

EVALUATION COMMENTS

This specification covers MS20218 antifriction bellcrank ball bearings intended primarily for use in aircraft control systems. It provides for seals to prevent entrance of contaminants and to retain lubricant throughout a temperature range of -67°F to +250°F. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, delete:

MIL-E-5272 Environmental Testing, Aeronautical and Associated Equipment, General Specification For

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipment)

MIL-STD-785 Reliability Program for System and Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements For

Paragraph 3.14--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.15--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.16--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.17--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

Paragraph 4.5.5--Revise the second sentence as follows:

Seals. The seals shall then operate in a test chamber at 3 revolutions per minute (rpm) while tested in accordance with the high temperature tests, Method 501, Procedure II, and the low temperature tests, Method 502, Procedure I, of Specification MIL-STD-810.

Paragraph 4.5.5--Add the following after the above sentence:

Seals. During operation in the high temperature tests, the bearings shall be subjected to the sand and dust test in accordance with Method 510, Procedure I, of Specification MIL-STD-810.

TITLE: Self-Aligning Antifriction Sealed Rod- B--Inadequate
End Double-Row Ball Bearings

EVALUATION COMMENTS

This specification covers sealed, self-aligning, antifriction rod-end ball bearings intended for use in aircraft control systems where high rotative speeds are not involved and temperature ranges are either -65°F to +250°F or -65°F to +350°F with 20-percent reduction of dynamic load carrying capacity. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Safety: No requirement specified
Reliability: No requirement specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

- MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)
- MIL-STD-785 Reliability Program for System and
Equipment Development and Production
- MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.10--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.11--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.12--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.13--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Airframe Antifriction Ball Bearings

B--Inadequate

EVALUATION COMMENTS

This specification covers antifriction bearings in the -65°F to +350°F temperature range intended for use in aircraft control systems where high rotative speeds are not encountered. Bearings governed by this specification include MS27640 through MS27649, all having Teflon seals to prevent entrance of contaminants and retain lubricant. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and Equipment,
Requirements For

Paragraph 3.15--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.16--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.17--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.18--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

Paragraph 4.3.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

Paragraph 4.5.7.1--Revise second sentence as follows:

Performance Test. The bearings shall be subjected to the sand and dust test in accordance with Method 510, Procedure I, of MIL-STD-810.

NUMBER: MIL-B-3990B (11 Dec 68)

12

TITLE: Airframe Antifriction Needle Roller Bearings B--Inadequate

EVALUATION COMMENTS

This specification covers the requirements for nonseparable, antifriction needle bearings primarily for use in aircraft control systems in which the load is primarily radial. Bearing types are specified by MS24461 through MS24466. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.10--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.11--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.12--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.13--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-B-5687C (12 Jun 62)

13

TITLE: Oil-Impregnated Sintered Metal-Powder Sleeve Bearings and Thrust Washers B--Inadequate

EVALUATION COMMENTS

This specification covers bearings which are permissible only in fast moving rotating applications such as in qualified motors or actuators. They shall not be used in flight control system applications with slow moving or oscillating motions. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.10--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.11--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.12--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.13--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.6.7--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.6.8--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: FF-B-185 (26 Dec 63)

14

TITLE: Cylindrical Roller Bearings and Self-Aligning Roller Bearings B--Inadequate

EVALUATION COMMENTS

This specification covers cylindrical and self-aligning roller bearings for general purpose use. The following deficiencies exist.

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.21--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.22--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.23--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.24--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.8.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.8.2--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: AMCP 706-203 (Apr 72)

15

TITLE: Engineering Design Handbook--
Helicopter Engineering, Part Three,
Qualification Assurance

B--Inadequate

EVALUATION COMMENTS

This document is the third volume of a three-part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and in AMCP 706-202, DETAIL DESIGN. These documents are not reviewed since they are not yet formally released.

TEST REQUIREMENTS

This volume, AMCP 706-203, defines the requirement for airworthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately upon specific tests and demonstrations of the complete helicopter system, airworthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements.

Factors bearing on the subject problem are contained in the following paragraphs:

Paragraph 3-1--System safety in accordance with MIL-STD-882 is specified.

Paragraph 7-2.4--Environmental tests specified in accordance with MIL-STD-810, MIL-E-5272, or MIL-T-5422 using combined environments where possible and operating equipment during test.

Paragraph 7-4.2.4--Environmental tests in accordance with MIL-STD-202 and MIL-STD-810 are described.

Paragraph 10-1--Reliability plan in accordance with MIL-STD-785 specified.

Paragraph 10-1.4.3--Reliability demonstration is specified.

Paragraph 10-2--Maintainability program is specified.

Paragraph 4-7.8--Maintainability reports in accordance with MIL-STD-470.

Paragraph 10-2.2.6--Maintainability demonstration is specified in accordance with MIL-STD-471.

The following deficiencies exist in the Specifications, Standards, and Other Government Documents:

MIL-E-5272, ENVIRONMENTAL TESTING, is inactive for new designs and is replaced by MIL-STD-810.

MIL-F-18372, FLIGHT CONTROL SYSTEMS, is a nonpreferred document, because it is less definitive than MIL-F-9490 in areas of design and test for safety, induced environment, reliability, and maintainability.

RECOMMENDATIONS

In the section on specifications and standards, delete:

MIL-E-5272 Environmental Testing, Aeronautical and Associated Equipment, General Specification For

MIL-F-18372 Flight Control Systems: Design Installation and Test of Aircraft, General Specification For

In the section on specifications and standards, add:

MIL-F-9490 (USAF) Flight Control Systems - Design, Installation and Test of, Piloted Aircraft, General Specification For

In the following paragraphs, delete MIL-E-5272:

Paragraph 6-6.2, Receiving Inspection and Test
Paragraph 7-2.4, Environmental Tests
Paragraph 7-4.2.4.1, Laboratory Environmental Simulation
Paragraph 7-4.2.4.1.3, Sand and Dust
Paragraph 7-4.2.4.3, Other Environments
Paragraph 9-10.4.2, Defogging, Defrosting, and Anti-Icing/Deicing Systems

In the following paragraphs, where MIL-E-5272 was deleted,
add MIL-STD-810:

Paragraph 6-6.2, Receiving Inspection and Test

Paragraph 7-4.2.4.1.3, Sand and Dust

Paragraph 9-10.4.2, Defogging, Defrosting and Anti-Icing
Deicing Systems

• In the following paragraphs, delete MIL-F-18372 and add
MIL-F-9490:

Paragraph 4-7.9.13, Flight Controls and Stability
Augmentation Systems

Paragraph 4-7.13, Test Plans and Qualification Test
Reports

Revise the document index in accordance with the above changes.

NUMBER: MIL-E-5272 (ASG) (22 Jan 71)

16

TITLE: General Specification for C--Not Applicable
Environmental Testing of Aeronautical
and Associated Equipment

EVALUATION COMMENTS

This specification, in accordance with Notice 1 dated 22 January 1971, is inactive for new design and is to be used only in procurement of replenishment spares as necessary to maintain equipment in the field until obsolescence or wear-out

This specification is superseded by MIL-STD-810 for new designs.

RECOMMENDATIONS: None

TITLE: Environmental Test Methods--
Method 510, Dust

B--Inadequate

EVALUATION COMMENTS

This standard establishes uniform environmental test methods, for determining the resistance of equipment to the effects of natural and induced environments peculiar to Military operations. Paragraph 1.2 states:

Test methods contained in this standard apply broadly to all items of equipment and generally represent the extreme conditions which usually constitute the minimum acceptable conditions. When it is known that the equipment will encounter conditions more severe or less severe than the environmental levels stated herein, the test may be modified by the equipment specification.

In spite of this statement, Method 510 is considered to be inadequate in not specifying additional details to be included in Paragraph 4 on equipment specifications.

RECOMMENDATIONS

Add the following to Method 510, Paragraph 4:

Summary

- (e) Whether humidity requirements should be varied
- (f) Whether equipment under test should be coated with a fluid film (such as grease, lubricating oil, hydraulic fluid)
- (g) Whether dust composition, structure, or size should be varied to meet special requirements
- (h) Whether equipment under test should be subjected to vibrational conditions while exposed to dust

Seals

GROUP: A-2

PROBLEM: Dirt contamination, wear, and distortion
of seals

TABLE XV. SPECIFICATION REVIEW SUMMARY--SEALS					
Specification			Adequacy*		
Number	Title		A	B	C
1	MIL-F-9490C (USAF) 9 Mar 66	General Requirements for Design, Installation, and Test of Piloted Aircraft Flight Control Systems	x		
2	MIL-F-18372 (AER) 31 Mar 55	General Specification for Design, Installation, and Test of Aircraft Flight Control Systems	x		
3	MIL-C-18244A (WEP) 1 Dec 62	General Specification for Automatic Piloted Aircraft Control and Stabilization Systems	x		
4	MIL-T-5955C 17 Sep 70	General Requirements for VTOL-STOL Transmission Systems	x		
5	MIL-H-5440F 18 Jan 72	Design and Installation Requirements for Aircraft Types I and II Hydraulic Systems	x		
6	MIL-H-8775C 8 Jan 64	General Specification for Aircraft and Missile Hydraulic System Components	x		
7	MIL-P-5518C 3 Dec 68	Design, Installation, and Data Requirements For Aircraft Pneumatic Systems	x		
8	MIL-P-8564D 18 Nov 70	General Specification for Aeronautical Pneumatic System Components	x		
9	MIL-C-5503C 26 Apr 72	General Requirements for Aeronautical Hydraulic Actuating Cylinders	x		
10	MIL-S-5049B 21 Dec 66	Piston Rod Scrapers	x		
11	MIL-G-5514F 15 Jan 69	General Requirements for Design of Glands and Hydraulic Packings	x		
*A--Adequate B--Inadequate C--Not Applicable					

TABLE XV - Continued					
Specification			Adequacy*		
Number	Title		A	B	C
12	MIL-P-5516C 29 Mar 71	Petroleum Hydraulic Fluid Resistant Preformed Packing, 160°F	x		
13	MIL-R-8791C 29 Jun 64	Tetrafluoroethylene Resin Hydraulic and Pneumatic Packing Retainer	x		
14	MIL-P-25732B 11 Jan 67	Petroleum Hydraulic Fluid Resistant Preformed Packing, 275°F	x		
15	MIL-T-8679 5 Mar 54	Helicopter Ground Test Requirements		x	
16	AMCP 706-203 Apr 72	Engineering Design Handbook-- Helicopter Engineering, Part Three, Qualification Assurance		x	
17	MIL-STD-810B 21 Sep 70	Environmental Test Methods-- Method 510, Dust		x	
18	MIL-T-5522C 25 Mar 66	General Test Procedure for Aircraft Hydraulic and Pneumatic Systems		x	
19	MIL-H-8891 1 Nov 61	Design, Installation, and Data Requirements for Type III Manned Flight Vehicle Hydraulic Systems			x
20	MIL-H-8890 1 Nov 61	General Specification for Type III Hydraulic Components (-65° to 450°F)			x
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: MIL-F-9490C (USAF) (9 Mar 66)

1

TITLE: General Requirements For Design,
Installation, and Test of Piloted
Aircraft Flight Control Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for design, installation, and test of the operating mechanism of all flight control systems for all USAF piloted aircraft. The following deficiencies (in addition to those identified in the bearing analysis) exist:

DESIGN REQUIREMENTS

Performance: Paragraph 3.3.9 inadequately specifies cycling requirements for actuating cylinders in helicopters.

Environmental: Paragraph 3.3.9.3 inadequately specifies requirements for actuating cylinders.

TEST REQUIREMENTS

Environmental: Paragraph 4.1.3.6.4 does not specify cycling of components under test for sand and dust.

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 3.3.9--Add the following to the existing paragraph:

Actuating Cylinders--Cylinders installed in helicopter flight control systems shall be cycled in accordance with requirements of the system specification.

Paragraph 3.3.9.3--Revise the second sentence as follows:

Environmental Conditions--In addition to the test requirements specified in MIL-C-5503, the tests specified in MIL-STD-810 shall be accomplished when required and as defined in the system specification.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.1.3.6.4--Add the following to the existing paragraph immediately after the first sentence:

Sand and Dust--Unless otherwise specified by the system specification, the equipment, while under test, shall be operated in a manner similar to that expected in actual service.

NUMBER: MIL-F-18372 (AEF) (31 May 55)

2

TITLE: General Specification for Design,
Installation, and Test of Aircraft
Flight Control Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for flight control systems in U.S. Navy piloted aircraft. General deficiencies were identified for this document in the analysis for bearings. This specification has extensive omissions in the area of actuating cylinders which will not be described in view of the recommendation below.

RECOMMENDATIONS

This specification is considered inferior to MIL-F-9490 for application to U.S. Army helicopter design and test. It is therefore recommended that MIL-F-9490 be considered the preferred specification and that it be referenced in U.S. Army design handbooks such as AMCP 706-203.

TITLE: General Specification for Automatic Piloted Aircraft Control and Stabilization Systems B--Inadequate

EVALUATION COMMENTS

This specification covers design, test, and performance requirements for either GFE or CFE automatic control and stabilization systems for all U.S. Navy piloted aircraft. Detail requirements for a particular system shall be as specified in the system specification. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirement inadequately specified

Safety: No requirement specified

Reliability: Paragraph 3.1.1.3.12.2 specifies R for structural protection only (Prevent prohibited maneuvers).

Maintainability: Paragraph 3.2.1 discusses accessibility in general terms.

TEST REQUIREMENTS

Environmental: Paragraph 4.3.5 references MIL-E-5272.

Maintainability: Demonstration is not specified.

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical and Associated Equipment, General Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipment)

MIL-STD-785 Reliability Program for System and Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements for

Paragraph 3.1.1.6.6--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.1.1.6.7--Add the following:

Safety: Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1.1.6.8--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785 and as specified in the system specification.

Paragraph 3.1.1.6.9--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.5--Revise second sentence as follows:

Test Procedures. Environmental testing shall be conducted on system components in accordance with MIL-T-5422 or MIL-STD-810 as required by the equipment system specification.

Paragraph 4.4.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with Reliability and Maintainability Program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative Reliability and Maintainability requirements in terms of failure rate, downtime and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-T-5955C (17 Sep 70)

TITLE: General Requirements for VTOL-STOL
Transmission Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for design and test of components intended for transmission of power to lift and propulsion devices and accessories of an aircraft or helicopter. The transmission system includes gearboxes, shafting, universal joints, couplings, rotor brake assembly, clutches, supporting bearings, accessory pads, and oil cooling fans. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military Environment: Paragraph 3.5.1, Requirements inadequately specified

Safety: No requirement specified

Reliability: Paragraph 3.5.2, Requirement inadequately specified

Maintainability: Paragraph 3.4.10, Requirement inadequately specified

TEST REQUIREMENTS

Environmental: No requirement specified

Reliability Demonstration: Paragraph 4.6.6, Endurance

Maintainability Demonstration: No requirement specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.5.1--Delete the existing paragraph and add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.5.4--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.5.2.1--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.4.10--Add the following to the existing paragraph:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.6.11--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD 810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.6.12--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-H-5440F (18 Jan 72)

5

TITLE: Design and Installation Requirements For Aircraft Types I and II Hydraulic Systems B--Inadequate

EVALUATION COMMENTS

This specification covers design and installation requirements for Type I (-65° to +160°F temperature range) and Type II (-65° to +275°F temperature range) aircraft hydraulic systems. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.2.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.2.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.2.3--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.2.4--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.2.3--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. The specific test parameters shall be in accordance with the applicable system specification. Unless stated otherwise by the system specification, the equipment, while under test, should be operated in a manner similar to that expected in actual service.

Paragraph 4.2.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-H-8775C (8 Jan 64)

6

TITLE: General Specification For Aircraft
and Missile Hydraulic System
Components

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements common to most hydraulic components used in aeronautical hydraulic systems. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental test requirements specify MIL-E-5272 in the following paragraphs:

3.3.20.5	Explosion Proof	4.5.11	Fungus
4.5.6.4	Temperature Limits	4.5.12	Sand and Dust
4.5.9	Vibration	4.5.13	Salt Fog
4.5.10	Humidity	4.5.15	Explosion Proof

There is no maintainability demonstration requirement specified.

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical
and Associated Equipment, General
Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.12--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.13--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.22--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.14--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

In the following paragraphs, delete the reference to MIL-E-5272 and replace with MIL-STD-810, Method No:

- 3.3.20.5 Explosion Proof: Method No. 511
- 4.5.6.4 Temperature Limits: Method No. 501 and 502
- 4.5.9 Vibration: Method No. 514
- 4.5.10 Humidity: Method No. 507
- 4.5.11 Fungus: Method No. 508
- 4.5.12 Sand and Dust: Method No. 510
- 4.5.13 Salt Fog: Method No. 509
- 4.5.15 Explosion Proof: Method No. 511

Paragraph 4.5.18--Delete and add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-P-5518C (3 Dec 68)

7

TITLE: Design, Installation, and Data Require- B--Inadequate
ments For Aircraft Pneumatic Systems

EVALUATION COMMENTS

This specification covers the design and installation of aircraft pneumatic systems. The working gas may be air, nitrogen, or a similar inert gas. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirements specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements for

Paragraph 3.11--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.12--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.13--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.14--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specification for Aeronautical B--Inadequate
Pneumatic System Components

EVALUATION COMMENTS

This specification covers the general requirements for pneumatic components used in aircraft systems conforming to Specification MIL-P-5518. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental test requirements specify MIL-E-5272 in the following paragraphs:

4.5.6.4	Temperature Limits	4.5.11	Fungus
4.5.9	Vibration	4.5.12	Sand and Dust
4.5.10	Humidity	4.5.13	Salt Fog

There is no maintainability demonstration requirement specified.

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical
and Associated Equipment, General
Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.12--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.13--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.21--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.14--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

In the following paragraphs, delete the reference to MIL-E-5272 and replace with MIL-STD-810, Method No.:

- 4.5.6.4 Temperature Limits: Method No. 501 and 502
- 4.5.9 Vibration: Method No. 514
- 4.5.10 Humidity: Method No. 507
- 4.5.11 Fungus: Method No. 508
- 4.5.12 Sand and Dust: Method No. 510
- 4.5.13 Salt Fog: Method No. 509

Paragraph 4.5.15--Delete the existing paragraph and add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-C-5503C (26 Apr 72)

9

TITLE: General Requirements for Aeronautical Hydraulic Actuating Cylinders B--Inadequate

EVALUATION COMMENTS

This specification applies to actuating cylinders covered by MIL-H-5440 and using only MIL-H-5606 hydraulic fluid. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: No requirement specified
Safety: No requirement specified
Reliability: No requirement specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirement specified
Reliability and Maintainability: No demonstration requirement specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.8--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.9--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the

course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.10--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.11--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.2.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.2.2--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The

demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Piston Rod Scrapers

B--Inadequate

EVALUATION COMMENTS

This document covers detail requirements for piston rod scrapers applicable to hydraulic or pneumatic actuating cylinders, shock struts, and similar equipment items. Scrapers are required to remove dirt, ice or other foreign matter from the sliding rod. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Safety: No requirement specified
Reliability: No requirement specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For System and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.8--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.9--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.10--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.11--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-G-5514F (15 Jan 69)

11

TITLE: General Requirements for Design of
Glands and Hydraulic Packings

A--Adequate

EVALUATION COMMENTS

This specification covers basic design criteria and procedures for application in design and installation of packings, gas-kets, and glands for use in hydraulic equipment designed in accordance with MIL-H-5440. The specification is definitive on standards for dimensions, shapes, surface finishes, nonextension devices, pressure limitations, and other mechanical design and installation considerations.

The specification is considered adequate as a general design guide. A requirement for environmental considerations at the item level in a generalized context such as this is inappropriate. Safety, reliability, and maintainability statements are also unrealistic in this context because they can only be applied only when the item is installed in an operating component assembly.

RECOMMENDATIONS

There are no recommendations for revision of this document.

TITLE: Petroleum Hydraulic Fluid Resistant Preformed Packing, 160°F

A--Adequate

EVALUATION COMMENTS

This specification covers packings and gaskets intended for use at a temperature range of -65°F to +160°F in hydraulic systems in accordance with MIL-P-5514 and MIL-H-5440, and shock absorbers using hydraulic fluid conforming only to MIL-H-5606.

The document provides design, performance, and test guidelines considered adequate at the item level.

Tests include hardness, tensile strength, elongation, and permanent set for units in new and aged conditions as well as tests for corrosion and adhesion, high- and low-temperature performance, and endurance cycling which are considered equivalent to environmental tests at this level.

Safety, reliability, and maintainability requirements are unrealistic in the context of this document, because they can be applied only when the item is installed in an operating component assembly.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-R-8791C (29 Jun 64)

13

TITLE: Tetrafluoroethylene Resin Hydraulic
and Pneumatic Packing Retainer

A--Adequate

EVALUATION COMMENTS

This specification covers TFE retainers intended for use in hydraulic and pneumatic system components as antiextrusion devices in conjunction with packings and gaskets. Retainers are required to function in fluids conforming to MIL-H-5606, MIL-H-6083, MIL-L-15016, MIL-F-17111, and MIL-H-19457, in a temperature range of -65°F to +275°F at operating pressures from 0 to 3,000 psi continuous and 0 to 4,500 psi intermittent without adverse effect on the properties of fluid, packing or metal contained in the system. The document defines design and construction requirements and specifies tests which are adequate to assure that these requirements are met and are considered equivalent to environmental tests at the line-item level.

Safety, reliability and maintainability requirements are unrealistic in the context of this document, because they can be applied only when the item is installed in an operating component assembly.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-P-25732B (11 Jan 67)

14

TITLE: Petroleum Hydraulic Fluid Resistant
Preformed Packing, 275°F

A--Adequate

EVALUATION COMMENTS

This specification covers packings and gaskets intended for use at a temperature range of -65°F to +275°F in hydraulic systems in accordance with MIL-P-5514, and shock absorbers using hydraulic fluid conforming only to MIL-H-5606. The document provides design, performance, and test guidelines considered adequate at the item level.

Tests include hardness, tensile strength, elongation, and permanent set for units in new and aged conditions as well as tests for corrosion, and adhesion, high- and low-temperature performance, and endurance cycling which are considered equivalent to environmental tests at this level.

Safety, reliability, and maintainability requirements are unrealistic in the context of this document, because they can be applied only when the item is assembled in an operating component.

RECOMMENDATIONS

There are no recommendations for revision of this document.

TITLE: Helicopter Ground Test Requirements B--Inadequate

EVALUATION COMMENTS

This specification provides for basic structure tests of the helicopter airframe, systems, and components under static and dynamic loading conditions. Test conditions are not conducive to those required for environmental tests. The following deficiencies exist:

DESIGN REQUIREMENTS: Not applicable

TEST REQUIREMENTS

Applicable Documents: Paragraph 2.1, specification MIL-E-5272 is inactive for new design

Environmental: Tests are not specified, with the exception of Paragraph 3.7.2, and are not considered appropriate in the context of this document. However, the environmental test specification should be referenced.

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical and Associated Equipment, General Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-810 Environmental Test Methods

Paragraph 3.1.12.2--Add the following:

Environmental Testing. Equipment designated for helicopters shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.7.2--Revise as follows:

Low-Temperature Tests. When required by the procuring activity, the transmission shall be subjected to the low-temperature tests, Procedure I, of specification MIL-STD-810.

Paragraph 3.1.12.3--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Engineering Design Handbook-- B--Inadequate
Helicopter Engineering, Part Three,
Qualification Assurance

EVALUATION COMMENTS

This document is the third volume of a three-part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and in AMCP 706-202, DETAIL DESIGN. These documents are not reviewed since they are not yet formally released.

TEST REQUIREMENTS

This volume, AMCP 706-203, defines the requirement for airworthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately upon specific tests and demonstrations of the complete helicopter system, airworthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups, and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification for that particular helicopter. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements.

Factors concerning the subject problem are contained in the analysis presented for bearings.

TITLE: Environmental Test Methods,
Method 510, Dust

B--Inadequate

EVALUATION COMMENTS

This standard establishes uniform environmental test methods for determining the resistance of environments peculiar to military operations.

Paragraph 1.2 states: "Test methods contained in this standard apply broadly to all items of equipment and generally represent the extreme conditions which usually constitute the minimum acceptable conditions. When it is known that the equipment will encounter conditions more severe or less severe than the environmental levels stated herein, the test may be modified by the equipment specification."

In spite of the above statement, Method 510 is considered to be inadequate in not specifying additional details to be included in Paragraph 4 on equipment specification.

RECOMMENDATIONS

Method 510, Paragraph 4--Add the following:

Summary

- (e) Whether humidity requirements should be varied.
- (f) Whether equipment under test should be coated with a fluid film (such as grease, lubricating oil, hydraulic fluid).
- (g) Whether dust composition, structure or size should be varied to meet special requirements.
- (h) Whether equipment under test should be subjected to vibrational conditions while exposed to dust.

TITLE: General Test Procedure for Aircraft B--Inadequate
Hydraulic and Pneumatic Systems

EVALUATION COMMENTS

This specification establishes standard methods for the testing of aircraft hydraulic systems designed in accordance with requirements of MIL-H-5440 and MIL-H-8891 and of aircraft pneumatic systems designed in accordance with requirements of MIL-P-5518. The following deficiencies exist:

DESIGN REQUIREMENTS: Not applicable

TEST REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications
Environmental: No requirement specified
Reliability and Maintainability: No demonstration requirement specified

RECOMMENDATIONS

Paragraph 2.1-- Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

Paragraph 3.3.5--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.3.6--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-H-8891 (1 Nov 61)

19

TITLE: Design, Installation, and Data C--Not Applicable
Requirements for Type III Manned
Flight Vehicle Hydraulic Systems

EVALUATION COMMENTS

This specification covers requirements for Type III manned flight vehicle hydraulic systems. Type III systems are designed for a temperature range of -65° to +450°F with pressure classifications of 3,000, 4,000 and 5,000 psi.

These design requirements are outside the normal range of helicopter operation, and this specification is therefore considered inapplicable.

RECOMMENDATIONS: None

NUMBER: MIL-H-8890 (1 Nov 61)

20

TITLE: General Specification for Type III C--Not Applicable
Hydraulic Components (-65° to
+450°F)

EVALUATION COMMENTS

This specification covers general requirements common to hydraulic components used in type III hydraulic systems (-65° to +450°F) conforming to specification MIL-H-8891.

These requirements are outside the normal range of helicopter operation, and this specification is therefore considered inapplicable.

RECOMMENDATIONS: None

Control Cables

GROUP: A-3

PROBLEM: Control cable wear due to dirt contamination

TABLE XVI. SPECIFICATION REVIEW SUMMARY--CONTROL CABLES						
Specification				Adequacy*		
Number		Title		A	B	C
1	MIL-F-9490C (USAF) 9 Mar 66	General Specification for Design, Installation, and Test of Piloted Aircraft Flight Control Systems		x		
2	MIL-F-18372 (Aer) 31 Mar 55	General Specifications for Design, Installation, and Test of Aircraft Flight Control Systems			x	
3	AMCP 706-203 Apr 72	Engineering Design Handbook--Helicopter Engineering, Part Three, Qualification Assurance			x	
4	MIL-W-5424B 10 Jan 72	Steel (Corrosion-Resisting) Preformed Flexible Wire Rope (For Aeronautical Use)			x	
5	MIL-C-18375A (ASG) 30 Aug 62	Steel (Corrosion-Resisting, Non-Magnetic) Preformed Flexible Cable (For Aeronautical Use)			x	
6	MIL-W-1511A 20 Feb 64	Steel (Carbon) Preformed Flexible Wire Rope			x	
7	MIL-F-7179E 15 Nov 72	General Specifications for Finishes and Coatings for Protection of Aerospace Weapons Systems, Structures, and Parts		x		
8	MIL-C-11796B 17 Nov 61	Hot-Application Petrolatum Corrosion Preventive Compound		x		
9	MIL-C-16173D 19 Nov 68	Cold-Application Solvent Cutback Corrosion Preventive Compound		x		
10	TM 55-1500-204-25/1 18 Jun 71	General Aircraft Maintenance Manual		x		
*A--Adequate B--Inadequate C--Not Applicable						

NUMBER: MIL-F-9490C (USAF) (9 Mar 66)

1

TITLE: General Specification for Design,
Installation, and Test of Piloted
Aircraft Flight Control Systems

A--Adequate

EVALUATION COMMENTS

The general deficiencies of this document have been identified in the analysis of bearings and revisions recommended. When these revisions are incorporated, this document is adequate for control cable design based on the following:

DESIGN REQUIREMENTS

Paragraph 3.2.13 specifies cable system requirements for clearance, fairleads, guards, loads alignment, attachments, tension size, and sheave spacing in addition to the above requirements for environment, safety, reliability and maintainability.

Paragraph 3.3 specifies cable in accordance with MIL-C-5424 and MIL-C-18.

TEST REQUIREMENTS

Paragraph 4.1.3.6 specifies appropriate environmental tests per MIL-STD-810 for all components subject to deterioration or malfunction due to any environmental condition.

RECOMMENDATIONS

No further revisions are recommended for this document.

NUMBER: MIL-F-18372 (Aer) (31 Mar 55)

2

TITLE: General Specifications for Design, Installation, and Test of Aircraft Flight Control Systems B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for flight control systems in U.S. Navy piloted aircraft. General deficiencies were identified for this document in the analysis of bearings. This specification has extensive omissions which will not be defined in view of the recommendation below. However, the document would be considered adequate for control cable applications if the revisions recommended under Bearings are accomplished.

RECOMMENDATIONS

This specification is considered inferior to MIL-F-9490 for application for U.S. Army helicopter design and test. It is therefore recommended that MIL-F-9490 be considered the preferred specification and that it be referenced in U.S. Army design handbooks, such as AMCP 706-203.

NUMBER: AMCP 706-203 (Apr 72)

3

TITLE: Engineering Design Handbook--
Helicopter Engineering, Part Three,
Qualification Assurance

B--Inadequate

EVALUATION COMMENTS

This document is the third volume of a three-part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and in AMCP 706-202, DETAIL DESIGN. These documents are not reviewed since they are not yet formally released.

TEST REQUIREMENTS

This volume, AMCP 706-203, defines the requirement for airworthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately upon specific tests and demonstrations of the complete helicopter system, airworthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups, and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification for that particular helicopter. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements.

Factors bearing on the subject problem are contained in the analysis presented for bearings.

NUMBER: MIL-W-5424B (10 Jan 72)

4

TITLE: Steel (Corrosion Resisting) Pre- B--Inadequate
formed Flexible Wire Rope (For
Aeronautical Use)

EVALUATION COMMENTS

This specification presents requirements for dimensions, properties, construction, and test to assure standardization of flexible preformed cable in aircraft structural applications. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.12--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.13--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.14--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.7--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.8--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Steel (Corrosion-Resisting, Non- B--Inadequate
Magnetic) Preformed Flexible Cable
(For Aeronautical Use)

EVALUATION COMMENTS

This specification presents requirements for physical dimensions, properties, construction, and test to assure standardization of flexible preformed cable in aircraft structural applications. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.9--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.10--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.11--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.12--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.7--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.3.8--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-W-1511A (20 Feb 64)

6

TITLE: Steel (Carbon) Preformed
Flexible Wire Rope

B--Inadequate

EVALUATION COMMENTS

This specification covers requirements for physical dimensions, properties, construction and testing to assure standardization of flexible preformed cable in aircraft applications. Deficiencies are as follows:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements for

Paragraph 3.8--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.9--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.10--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.11--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specifications for Finishes and Coatings for Protection of Aerospace Weapons Systems, Structures, and Parts A--Adequate

EVALUATION COMMENTS

This specification covers the protection of aerospace weapon system parts, including spares, against deterioration. It specifies the appropriate specifications, methods, and materials for cleaning, surface treatment, and application of finishes and protective coatings to parts and surfaces of aircraft assemblies such as fuselages, wings, cowls, rotor blades, and floats. This document does not apply to government or standard contractor-furnished accessories such as electric motors, generators, switches, hydraulic valves, and similar parts.

The nature of this document precludes its assessment by the current design and test criteria, but it is considered adequate for its purpose. The following paragraph is pertinent to the subject problem:

5.5. Control Cables and Chains. Control cables and control chains shall not be painted. Cables shall, however, be protected by a dip-coating of material conforming to MIL-C-11796, Class 2, or other approved corrosion-preventive materials prior to installation. After installation, they shall be inspected and touched up with the same material, or material conforming to MIL-C-16173, Grade 1 for cables in exterior locations or Grade 4 for cables on the interior of the weapons systems.

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-C-11796B (17 Nov 61)

8

TITLE: Hot-Application Petrolatum
Corrosion Preventive Compound

A--Adequate

EVALUATION COMMENTS

This specification covers the design and test requirements of a petrolatum-base corrosion preventive compound of several classes for various applications. This compound, Class 2, is specified by MIL-F-7179 for protective application to aircraft control cables before installation.

The document is considered adequate although the nature of the product does not lend itself to document analysis by the criteria established.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-C-16173D (19 Nov 68)

9

TITLE: Cold-Application Solvent Cutback
Corrosion Preventive Compound

A--Adequate

EVALUATION COMMENTS

This specification covers design and test requirements for solvent dispersed corrosion preventive compounds which deposit thin easily removable films after evaporation of solvent. This compound, Grade 1 (exterior) or Grade 4 (interior), is specified by MIL-F-7179 for application to aircraft control cables as a touch-up after installation.

The document is considered adequate although the nature of the product does not lend itself to document analysis by the criteria established.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: TM 55-1500-204-25/1 (18 Jun 71)

10

TITLE: General Aircraft Maintenance
Manual

A--Adequate

EVALUATION COMMENTS

This manual provides general instructions for maintenance policies, practices, and procedures used by maintenance personnel for U.S. Army aircraft. Instructions are to be used as a guide in familiarizing personnel with measures to inspect, maintain, preserve, identify, or dispose of aircraft and related equipment. Instructions are general; specific details required for a particular aircraft or piece of equipment will be obtained from the applicable technical manual.

The following paragraph addresses the subject problem:

3-390. Control Cables. Inspection and replacement criteria are provided as well as corrosion preventive measures and emergency repair and test procedures. MIL-C-16173, Grade 4, is specified for corrosion prevention.

RECOMMENDATIONS

There are no recommendations for revision of this handbook.

CORROSION (METAL)Airframe

GROUP: B-1

PROBLEM: Airframe corrosion and deterioration due to fluid entrapment and washing techniques

TABLE XVII. SPECIFICATION REVIEW SUMMARY--AIRFRAMES					
Specification				Adequacy*	
Number		Title	A	B	C
1	MIL-F-7179E 15 Nov 72	General Specification for Finishes and Coatings for Protection of Aerospace Weapons Systems, Structures, and Parts	x		
2	MIL-S-5002C 26 Jul 71	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems	x		
3	MIL-F-18264D 23 Apr 71	Application and Control of Weapons System Organic Finishes	x		
4	MIL-C-7439 24 Feb 72	Rain Erosion Resistant and Rain Erosion Resistant With Anti-Static Treatment Elastomeric Coating System for Exterior Aircraft and Missile Plastic Parts	x		
5	MIL-R-7575C 9 Jun 72	Low-Pressure Laminating Polyester Resin	x		
6	MIL-R-9300B 15 Jan 68	Low-Pressure Laminating Epoxy Resin	x		
7	MIL-W-6729A 10 Sep 62	General Specification for Testing Watertightness of Aircraft	x		
8	TM 55-1500-204-25/1 18 Jun 71	General Aircraft Maintenance Manual	x		
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: MIL-F-7179E (15 Nov 72)

1

TITLE: General Specification for Finishes
and Coatings for Protection of Aero-
space Weapons Systems, Structures,
and Parts

A--Adequate

EVALUATION COMMENTS

This specification covers the protection of aerospace weapon system parts, including spares, against deterioration. It specifies the appropriate specifications, methods, and materials for cleaning, surface treatment, and application of finishes and protective coatings to parts and surfaces of aircraft assemblies such as fuselages, wings, cowls, rotor blades, and floats. This document does not apply to government or standard contractor-furnished accessories such as electric motors, generators, switches, hydraulic valves, and similar parts.

The nature of this document precludes its assessment by the current design and test criteria. The following paragraphs are applicable to the subject problem:

- 3.1.2--Contractor's Finish Specification specifies the contractors' responsibility to provide an adequate finish specification using this document as the basis
- 4.1--Protective finish requirements defined
- 4.3--Surface treatment
- 5.2--Faying surfaces, joints, and seams
 - 5.2.2--Surfaces of dissimilar metals
 - 5.2.3--Sealing
- 5.11--Areas subjected to corrosive fluids
- 5.12--Resistance to synthetic lubricants
- 5.19--Magnesium parts

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-S-5002C (26 Jul 71)

2

TITLE: Surface Treatments and Inorganic
Coatings for Metal Surfaces of
Weapons Systems

A--Adequate

EVALUATION COMMENTS

This specification covers requirements for cleaning, surface treatments, and inorganic coatings for metallic surfaces of aerospace weapons systems. It specifies the appropriate specifications, materials, and methods for cleaning and protection of all types of metallic surfaces. The nature of this document and the products involved preclude its assessment by the design and test criteria established.

The following paragraphs are applicable to the subject problem:

- 3.4--Cleaning - General Description
- 3.4.1--Organic Contamination Removal
- 3.4.2--Inorganic Contamination Removal
- 3.4.2.8--Rinsing
- 3.5--Surface Treatments of Aluminum and Aluminum Alloys
- 3.6--Surface Treatments of Magnesium Alloys
- 3.7.3--Coatings for Corrosion Control

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-F-18264D (23 Apr 71)

3

TITLE: Application and Control of
Weapons System Organic Finishes

A--Adequate

EVALUATION COMMENTS

This specification covers the detailed requirements and procedures to be followed in the application and control of organic finishing materials on weapons systems. The materials used, unless otherwise specified, are to conform to the requirements of MIL-F-7179. The following paragraphs are applicable:

- 5.1--Preparation of Metal Surfaces per MIL-F-7179
- 5.1.1--Surface Treatment per MIL-S-5002
- 5.1.3--Cleaning, General
- 5.2--Coating Systems
- 5.3--Exterior Finishing Procedures
- 5.3.2.1--Exterior Finish of Glass-Fiber-Reinforced
Plastic Parts
- 12--Interior Finishing Procedures

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-C-7439 (24 Feb 72)

4

TITLE: Rain Erosion Resistant and Rain Erosion Resistant With Anti-Static Treatment Elastomeric Coating System for Exterior Aircraft and Missile Plastic Parts A--Adequate

EVALUATION COMMENTS

This specification establishes the requirement for two classes of rain-erosion-resistant coating systems for glass fabric base plastic laminates and other plastics used for aircraft and missile exterior parts. The system includes primer and rain-erosion-resistant coating of solvent-dispersed elastomeric base for Class 1 plus an antistatic coating of solvent-dispersed elastomeric base for Class 2.

The following paragraphs are applicable:

DESIGN REQUIREMENTS

- 3.11--Repairability
- 3.17.1--Aromatic fuel resistance
- 3.17.2--Rain erosion resistance
- 3.17.3--Water immersion resistance
- 3.17.4--Durability (weathering)

TEST REQUIREMENTS

- 4.5--Aromatic fuel and water immersion tests
- 4.3.2.3--Rain erosion test
- 4.3.2.2--Durability test

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-R-7575C (9 Jun 72)

5

TITLE: Low-Pressure Laminating
Polyester Resin

A--Adequate

EVALUATION COMMENTS

This specification covers the requirements for low-pressure laminating polyester resins used in fabricating glass-fabric-based plastic laminates for general structural parts, aircraft radio and radar antenna housings and other applications. Required physical and electrical properties are specified after exposure to certain conditions as noted in the following paragraphs:

4.5.1--Standard conditions

4.5.2--Wet conditions (immersion in boiling water
for 2 hours)

4.5.3--Exposure to 70°C (158°F) for 1/2 hour

4.5.4--Immersion in chemical fluids

4.5.5--Outdoor weathering for one year

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-R-9300B (15 Jan 68)

6

TITLE: Low-Pressure Laminating
Epoxy Resin

A--Adequate

EVALUATION COMMENTS

This specification covers the requirements for low-pressure laminating epoxy resins used in fabricating glass-fabric-based plastic laminates for general structural parts, aircraft radio and radar antenna housings, and other applications. Required physical and electrical properties are specified after exposure to certain conditions, as noted in the following paragraphs:

4.5.1--Standard conditions

4.5.2--Wet conditions (immersion in boiling water
for 2 hours)

4.5.3--Exposure to 70°C (158°F) for 1/2 hour

4.5.5--Immersion in chemical fluids

4.5.6--Outdoor weathering for one year

RECOMMENDATIONS

There are no recommendations for revision of this specification.

NUMBER: MIL-W-6729A (10 Sep 62)

7

TITLE: General Specification For Testing
Watertightness of Aircraft

A--Adequate

EVALUATION COMMENTS

This specification covers procedures for testing of the aircraft to insure watertightness when exposed to heavy rainfall. Tests are classified as ground and flight acceptance tests and are defined as follows:

Paragraph 4.5.1--Flight Test. Aircraft will be flown through heavy rain for sufficient time to check for leaks.

Paragraph 4.5.2--Ground Test. Simulated heavy rain varying from 2 to 4 inches per hour over a 2-hour period.

Paragraph 4.5.1--Leakage checks are to be made at points designed by the listed appropriate paragraphs in Bureau of Naval Weapons Specification SD-24 Volumes I and II, GENERAL SPECIFICATION FOR DESIGN AND CONSTRUCTION OF AIRCRAFT WEAPONS SYSTEMS.

RECOMMENDATIONS

There are no recommendations for revision of this specification.

TITLE: General Aircraft Maintenance
Manual

A--Adequate

EVALUATION COMMENTS

This manual provides general instructions for maintenance policies, practices, and procedures used by maintenance personnel for Department of Army aircraft. The instructions are to be used as a guide in familiarizing personnel with measures to inspect, maintain, preserve, identify, or dispose of aircraft and related equipment. Instructions are general; specific details required for a particular aircraft or piece of equipment will be obtained from the applicable technical manual.

Specific references to the subject problem are made in the following paragraphs:

Paragraph 3-7--Cleaning, general - materials and procedures
Paragraph 3-9--Alkaline Method of Cleaning - ratio of MIL-C-25769 to water for various surfaces and conditions

Table 3-1--The name and specification number of all approved cleaning materials are listed.

Paragraph 3-11--Solvent cleaning procedures

Paragraph 3-13--Engine and equipment cleaning

Paragraph 3-14c--Transparent inclosures

Paragraph 3-14e--Use of protective covers for magnesium parts, brakes, actuators, switches, etc.

Paragraph 3-14f--Battery acid removal procedure

Paragraph 3-14g--Cleaning antifriction bearings

Paragraph 3-14h--Cleaning electrical equipment

Paragraph 3-14i--Cleaning relief tube areas after each flight

Paragraph 3-14j--Removal of corrosion preventive compound

Paragraph 3-14k--Removal of fungus growth

Paragraphs 3-35 to 3-45--Corrosion treatment

RECOMMENDATIONS

There are no recommendations for revision of this handbook.

Switches

GROUP: B-2

PROBLEM: Moisture and corrosion cause switches to fail

TABLE XVIII. SPECIFICATION REVIEW SUMMARY--SWITCHES					
Specification			Adequacy*		
Number	Title		A	B	C
1	MIL-I-8700A 1 May 70	General Specification for Installation and Test of Electronic Equipment in Aircraft		x	
2	MIL-E-5400P 2 Jul 73	General Specification for Airborne Electronic Equipment		x	
3	MIL-E-7080B 29 Apr 68	Selection and Installation of Aircraft Electrical Equipment		x	
4	MIL-STD-454C 1 May 72	Standard General Requirements for Electronic Equipment		x	
5	MIL-STD-202E 16 Apr 73	Test Methods for Electronic and Electrical Component Parts	x		
6	MIL-T-5422F (AS) 30 Nov 71	Environmental Testing of Airborne Electronic and Associated Equipment	x		
7	MIL-STD-1132 31 May 72	Selection and Use of Switches and Associated Hardware	x		
8	MIL-S-9395D 11 Apr 73	General Specification for Pressure Switches (Absolute, Gauge, and Differential)		x	
9	MIL-S-3786D 7 Jun 73	General Specification for Rotary Switches (Circuit Selector, Low-Current Capacity)		x	
10	MIL-S-6807D 25 Sep 68	General Specification for Selector Power Rotary Switches		x	
11	MIL-S-3950E 21 Sep 73	Environmentally Sealed Toggle Switches		x	
*A--Adequate B--Inadequate C--Not Applicable					

TABLE XVIII - Continued					
Specification				Adequacy*	
Number		Title	A	B	C
12	MIL-S-8805C 22 May 72	General Specification for Sensitive and Push (Snap Action) Switches and Switch Assemblies		x	
13	MIL-B-5423B 3 Feb 72	General Specification for Dust and Water Seal Boots (For Toggle and Pushbutton Switches, Circuit Breakers, and Rotary Actuated Parts)		x	
*A--Adequate B--Inadequate C--Not Applicable					

TITLE: General Specification For Installation and Test of Electronic Equipment in Aircraft B--Inadequate

EVALUATION COMMENTS

This specification provides general guidelines and desirable characteristics of electronic installations. While this document cannot cover all possible design installation problems, it does provide a comprehensive list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific design and test requirements.

Paragraph 3.3.1.2 specifies switches in accordance with MIL-STD-454, Requirement 58.

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: Requirement inadequately specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipment)

MIL-STD-785 Reliability Program for System and Equipment Development and Production

MIL-STD-810 Environmental Test Methods

Paragraph 3.4.3--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.9.1--Add the following prior to existing sentence:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.14--Add the following to the existing sentence:

Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

Paragraph 4.2.2.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202 or MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.2.2--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specification for Airborne
Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for airborne electronic equipment for operation primarily in piloted aircraft. It is intended for use in incorporating in detail equipment specifications those requirements which are common to most airborne electronic equipment. The detail performance and test requirements for a particular equipment shall be as specified in the detail specification for that equipment.

Paragraph 3.1.22 specifies switches in accordance with MIL-STD-454, Requirement 58. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement inadequately specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 3.2.22--Revise existing sentence as follows:

Safety (personnel hazard). Provisions for personnel safety shall be in accordance with MIL-STD-434, Requirement 1, and MIL-STD-882.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Selection and Installation of
Aircraft Electrical Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for installation and selection of electrical equipment in piloted aircraft. While this document cannot cover specific design installation problems, it provides general guidelines and a list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific requirements.

Paragraph 3.1.8.7.2 specifies that electrical equipment will be protected from environmental conditions existing in the aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 - Environmental Testing, Aeronautical and Associated Equipment, General Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and Equip-
ment, Requirements for

Paragraph 3.1.8.2--Revise as follows:

Fire Hazard. Electric equipment installed in an environment having explosive vapors present shall conform to the requirements of the explosion-proof tests of Specification MIL-STD-810, Method 511.

Paragraph 3.1.8.7.2--Add the following to the existing paragraph:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.1.1.1--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1.8.1--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.1.8.7.4--Delete the existing paragraph and add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability.

The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.1.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.3--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-STD-454C (1 May 72)

4

TITLE: Standard General Requirements
for Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This standard covers common requirements to be used in military specifications for electronic equipment. It contains 67 requirements covering a broad scope of design and test considerations which are in turn further defined by applicable specifications. Requirements include such areas as safety, human factors, thermal design, moisture pockets, reliability and maintainability.

Switches are defined in Requirement 58 by reference to MIL-STD-1132. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement 1 does not specify the applicable document for safety requirements.

TEST REQUIREMENTS: None

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Requirement 1, Paragraph 2--Add the following:

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements for

Requirement 1, Paragraph 4--Add the following to the existing paragraph:

Safety requirements shall be in accordance with MIL-STD-882.

TITLE: Test Methods for Electronic and
Electrical Component Parts

A--Adequate

EVALUATION COMMENTS

This standard establishes uniform methods for testing electronic, and electrical component parts, including environmental tests to determine resistance to deleterious effects of natural elements and conditions surrounding military operations. The term component parts includes such items as capacitors, resistors, switches, relays, transformers, and jacks.

The requirements which must be met by these component parts are specified in the individual product specifications, and they must be tested accordingly using the methods as described herein.

Method 103B, Humidity (Steady State), and Method 106D, Moisture Resistance, provide adequate tests for the subject condition.

RECOMMENDATIONS

This standard is preferred for testing of electrical and electronic equipment since it is a DOD document and is more comprehensive than MIL-T-5422, which is a Navy document.

TITLE: Environmental Testing of Airborne
Electronic and Associated Equipment

A--Adequate

EVALUATION COMMENTS

This is a Navy Department specification which contains procedures for testing airborne electronic and associated equipment, under environmental conditions, to demonstrate compliance with MIL-E-5400, MIL-T-21200, other general design specifications, and applicable detailed equipment specifications.

Paragraph 3.2 states: If the detail equipment specification modifies these limits or conditions (environmental) the limits or conditions specified herein shall be modified to correspond to the limits or conditions specified in the detail equipment specification.

This document contains 14 test procedures, of which 9 are roughly comparable to MIL-STD-810B but are oriented to Navy airborne electronic equipment.

RECOMMENDATIONS

There are no recommendations for revision of this document. However, it should be considered a nonpreferred specification for U.S. Army aircraft in deference to the more comprehensive MIL-STD-202.

NUMBER: MIL-STD-1132 (31 May 73)

7

TITLE: Selection and Use of Switches
and Associated Hardware

A--Adequate

EVALUATION COMMENTS

This standard establishes requirements for selection of switches and their associated hardware including standard types chosen jointly by the department of the Army, Navy, and Air Force. It also has guides for choice and application in military equipment. All switches are identified by name, application, and detail specification number. The following paragraphs are applicable:

Paragraph 4--General Requirements

Paragraph 4.1--Choice of switch types provides criteria for selection by the designer.

Paragraph 5.1--Detailed requirements for standard switch types are contained in the applicable switch specification and in the applicable section of this standard.

RECOMMENDATIONS

There are no recommendations for revision of this document.

TITLE: General Specification for Pressure Switches (Absolute, Gauge and Differential) B--Inadequate

EVALUATION COMMENTS

This specification is intended for, but not limited to, use in selection of pressure switches during system design, individual component design, and procurement.

Electrical, physical, and environmental requirements are adequate. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.8--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being

accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.9--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.10--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.4.5--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-S-3786D (7 Jun 73)

9

TITLE: General Specification for Rotary
Switches (Circuit Selector, Low-
Current Capacity)

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for the subject switches primarily for use in electronic and communications equipment. Printed-circuit-wafer-type switches are excluded from this specification. Adequate environmental design requirements and test procedures per MIL-STD-202 are specified, for example:

Design Requirements

3.10--Thermal Shock
3.13--Sand and Dust
3.18--Moisture Resistance
3.21--Salt Spray (Corrosion)

Test Requirements

4.8.6--Thermal Shock, Method 107, MIL-STD-202
4.8.9--Sand and Dust, Method 110, MIL-STD-202
4.8.14--Moisture Resistance, Method 106, MIL-STD-202
4.8.17--Salt Spray (Corrosion), Method 101, MIL-STD-202

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration require-
ment specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.31--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.32--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.33--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.5.5--Add the following:

Reliability and Maintainability Demonstration.

Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-S-6807D (25 Sep 68)

10

TITLE: General Specification for
Selector Power Rotary Switches

B--Inadequate

EVALUATION COMMENTS

This specification covers the general requirements for closed-construction rotary switches designed for use in power circuits and capable of making, carrying, and breaking electrical loads of up to and including 10 amperes. Adequate environmental design requirements and test procedures in accordance with MIL-STD-202 are specified, for example:

Design Requirements

3.11--Thermal Shock
3.19--Moisture Resistance
3.20--Salt Spray (Corrosion)
3.21--Sand and Dust

Test Requirements

4.9.7--Thermal Shock, Method 107, MIL-STD-202
4.9.15--Moisture Resistance, Method 106, MIL-STD-202
4.9.16--Salt Spray (Corrosion), Method 101, MIL-STD-202
4.9.17--Sand and Dust, Method 110, MIL-STD-202

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.25--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.26--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.27--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.5.4--Add the following:

Reliability and Maintainability Demonstration.
Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-S-3950E (21 Sep 73)

11

TITLE: General Specification for
Environmentally Sealed Toggle
Switches

B--Inadequate

EVALUATION COMMENTS

This specification covers the military requirements for environmentally sealed toggle switches. Environmental design requirements and test procedures in accordance with MIL-STD-202 are considered adequate, for example:

Design Requirements

3.6.14--Salt Spray (Corrosion)
3.6.15--Thermal Shock
3.6.16--Moisture Resistance
3.6.17--Sand and Dust
3.6.18--Switch Sealing

Test Requirements

4.10.16--Salt Spray, Method 101, MIL-STD-202
4.10.17--Thermal Shock, Method 107, MIL-STD-202
4.10.18--Moisture Resistance, Method 106, MIL-STD-202
4.10.19--Sand and Dust, Method 110, MIL-STD-202

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirement specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.9--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.10--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.11--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATION FOR TEST REQUIREMENTS

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration.

Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-S-8805C (22 May 72)

12

TITLE: General Specification for Sensitive and Push (Snap Action) Switches and Switch Assemblies B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for snap action, sensitive, and push switches and switch assemblies. Adequate environmental design requirements and test procedures per MIL-STD-202 are specified, for example:

Design Requirements

- 3.14--Thermal Shock
- 3.18--Moisture Resistance
- 3.19--Salt Spray (Corrosion)
- 3.22--Sand and Dust

Test Requirements

- 4.8.10--Thermal Shock, Method 107, MIL-STD-202
- 4.8.14--Moisture Resistance, Method 106, MIL-STD-202
- 4.8.15--Salt Spray (Corrosion), Method 101, MIL-STD-202
- 4.8.18--Sand and Dust, Method 110, MIL-STD-202

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.36--Add the following

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.37--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.38--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration.

Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specification for Dust and Water Seal Boots (For Toggle and Pushbutton Switches, Circuit Breakers, and Rotary-Actuated Parts) B--Inadequate

EVALUATION COMMENTS

This specification covers the general requirements for molded silicone-rubber boots used to protect the switch-actuating mechanism from sand, dust, water, and other contaminants and to seal the panel on which the switches are mounted, adequate environmental design requirements and test procedures are specified, for example:

Design Requirements

- 3.3.3--Lubricant
- 3.6--Sand and Dust
- 3.8--Salt Spray (Corrosion)
- 3.10--Water tightness

Test Requirements

- 4.7.2.1--Lubricant exposure at high and low temperature
- 4.7.4--Sand and Dust, Method 110, MIL-STD-202
- 4.7.6--Salt Spray (Corrosion) Method 101, MIL-STD-202
- 4.7.8--Water Tightness--Leak check while cycling switches under water

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards
Safety: No requirement specified
Reliability: No requirement specified
Maintainability: No requirement specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements for

Paragraph 3.13--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.14--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

Decals and Identification Tapes

PROBLEM: Deterioration of decals and identification tapes

TABLE XIX. SPECIFICATION REVIEW SUMMARY-- MARKING MATERIALS					
Specification			Adequacy*		
Number	Title		A	B	C
1	TM55-1500-204- 25/1 18 Jun 71	General Aircraft Maintenance Manual		x	
2	MIL-D-8634B 12 Oct 71	Identification Markers			x
3	MIL-D-8635B 30 Jun 71	Decals for Use on Interior Surfaces			x
4	MIL-M-43719A 13 Jul 72	General Specification for Pig- mented Elastomeric Adhesive Marking Materials and Markers		x	
5	MIL-P-38477A (USAF) 30 Aug 73	Pressure-Sensitive Adhesive Plastic Material for Aerospace Identification and Marking		x	
6	MIL-I-8700A 1 May 70	General Specification for Installation and Test of Elec- tronic Equipment in Aircraft		x	
7	MIL-E-5400P 2 Jul 73	General Specification for Air- borne Electronic Equipment		x	
8	MIL-E-7080B 29 Apr 68	Selection and Installation of Aircraft Electric Equipment		x	
9	MIL-STD-454C 1 May 72	Standard General Requirements for Electronic Equipment		x	
10	MIL-W-5088E 2 Jan 74	Installation of Aircraft Wiring		x	
11	MIL-STD-681B 6 Feb 67	Identification Coding and Appli- cation of Hookup and Lead Wire			x
*A--Adequate B--Inadequate C--Not Applicable					

TABLE XIX - Continued					
Number		Specification	Adequacy*		
Title			A	B	C
12	MIL-STD-1247B 20 Dec 68	Markings, Functions, and Hazard Designations of Hose, Pipe, and Tube Lines for Aircraft, Missile, and Space Systems	x		
13	MIL-T-9906A 2 Mar 70	Aircraft Tubing Identification Marker Tape (Non-Corrosive, Heat, Cold, and Solvent Resistant)	x		
14	L-T-90C 3 Nov 65	Pressure-Sensitive Adhesive Tape (Cellophane and Cellulose Acetate)			x
15	L-T-99a 11 Sep 58	Pressure-Sensitive Adhesive Identification Tape (Acetate-Fiber)			x
16	L-T-100a 30 Aug 60	Pressure-Sensitive Adhesive Polyester Film Tape		x	
17	PPP-T-60D 25 Jun 71	Waterproof Packaging Tape			x
18	PPP-T-66D 1 May 69	Pressure-Sensitive Adhesive Vinyl Plastic Film Tape			x
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: TM 55-1500-204-25/1 (18 Jun 71)

1

TITLE: General Aircraft Maintenance
Manual

B--Inadequate

EVALUATION COMMENTS

This manual provides general instructions for maintenance policies, practices, and procedures used by maintenance personnel for Department of the Army aircraft. Instructions are to be used as a guide in familiarizing personnel with measures to inspect, maintain, preserve, identify, or dispose of aircraft and related equipment. Instructions are general; specific details required for a particular aircraft or piece of equipment will be obtained from the applicable technical manual.

The subject problem is addressed in the following paragraphs:

3-140--Application and Removal of Decalcomanias
3-155--Application and Installation of Identification
Tapes

The following deficiencies exist:

Paragraph 3-142--Military Specifications MIL-D-8634 and MIL-D-8635 are invoked. These documents have been cancelled.

Paragraph 3-159d--Type III tape, Federal Specification L-T-90 or L-T-99, is specified. Neither specification provides a Type III and both are nonpermanent tapes intended primarily for office use.

Paragraph 3-161d--Type II tape, Federal Specification L-T-90 or L-T-99, is specified. Both are nonpermanent tapes intended primarily for office use.

RECOMMENDATIONS

Paragraph 3-142--Revise the second sentence as follows:

These decals are suitable for exterior and interior surface application as governed by Military Specification MIL-M-43719.

Paragraph 3-159d--Delete the existing sentence and add the following:

Pressure-sensitive tape, Military Specification MIL-T-9906, in accordance with Military Standard MIL-STD-1247, shall be used for this system.

Paragraph 3-161d--Delete the existing sentence and add the following:

Pressure-sensitive tape, Military Specification MIL-T-9906, in accordance with Military Standard MIL-STD-1247, shall be used for this system.

NUMBER: MIL-M-8634B (12 Oct 71)

2

TITLE: Identification Markers

C--Not Applicable

EVALUATION COMMENTS

This specification, dated 14 August 1961, has been cancelled by Notice 1, dated 12 October 1971, and superseded by MIL-M-43719.

RECOMMENDATIONS: None

NUMBER: MIL-D-8635B (30 Jun 71)

3

TITLE: Decals For Use on Interior
Surfaces

C--Not Applicable

EVALUATION COMMENTS

This specification, dated 3 May 1962, has been cancelled by Notice 1, dated 30 June 1971. Types I, II, III, and IV decals are no longer required and have no superseding document. Type V decals are superseded by Type I, Class 1, of MIL-M-43719.

RECOMMENDATIONS: None

NUMBER: MIL-M-43719A (13 Jul 72)

4

TITLE: General Specification for Pigmented B--Inadequate
Elastomeric Adhesive Marking Materials
and Markers

EVALUATION COMMENTS

This specification covers general requirements for adhesive-backed, pigmented, elastomeric marking materials in roll and sheet form available in three types and two classes:

Type I--Pressure-sensitive adhesive
Type II--Positionable pressure-sensitive adhesive
Type III--Heat activated adhesive
Class 1--High adhesion (Permanent)
Class 2--Low adhesion (temporary) (Types I & II only)

Requirements and tests are specified for properties of adhesion, tensile strength, elongation, shrinkage, flexibility, corrosivity, and resistance to water, fuel, and weather. The following deficiencies exist:

DESIGN REQUIREMENTS

Environmental: No fluid immersion requirements are specified for the following:

Jet Engine Fuel (MIL-J-5624, Grade JP-4)
Aircraft Hydraulic Oil (MIL-H-5606 and MIL-H-8446)
Lubricating Oil (MIL-L-7808 and MIL-L-23699)

TEST REQUIREMENTS

Paragraph 4.5.12--Water immersion for 8 hours is inadequate.

Paragraph 4.5.13--Fuel immersion for 1 hour is inadequate.

No fluid immersion tests are specified for jet engine fuel, hydraulic oil, or lubricating oil.

No test is specified for adhesion properties after fluid exposure.

RECOMMENDATIONS

The revisions required to make this specification adequate are extensive, and providing them in detail is beyond the scope of this report. It is therefore recommended that the noted deficiencies be corrected using MIL-T-9906 as a guide. The appropriate paragraphs are listed below.

Design Requirements

3.3--Physical Properties (Table I)

3.5.2--Fluid Resistance

3.5.3--Heat Resistance

Test Requirements

4.10.2--Adhesion

4.11--Fluid Resistance

4.11.1--Water (24 hours)

4.11.2--Jet Engine Fuel (72 hours)

4.11.3--Petroleum Base Hydraulic Oil (72 hours)

4.11.4--Nonpetroleum Base Hydraulic Fluid (72 hours)

4.11.5--Lubricating Oil at 200°F (24 hours)

4.12--Heat Resistance at 325°F (100 hours)

NUMBER: MIL-P-38477A (USAF) (30 Aug 73)

5

TITLE: Pressure-Sensitive Adhesive Plastic B--Inadequate
Material for Aerospace Identification
and Marking

EVALUATION COMMENTS

This specification covers an adhesive-backed, pigmented or clear, polyester plastic film for marking of aerospace interior and exterior surfaces which will not be subjected to heat above 225°F. The material is supplied in roll or sheet form as follows:

Type I--Nonperforated
Type II--Perforated
Class 1--Plain
Class 2--With protective masking sheet on side

Requirements and tests are specified for properties of adhesion, tensile strength, elongation, shrinkage, flexibility, corrosivity, and resistance to water, fuel, hot oil, salt spray, and weather. The following deficiencies exist:

DESIGN REQUIREMENTS

Environmental: No fluid immersion requirements are specified for aircraft hydraulic oil (MIL-H-5606 and MIL-H-8446).

TEST REQUIREMENTS

Paragraph 4.8.11--Water resistance test for 8 hours is inadequate.

Paragraph 4.8.11.2--Fuel resistance test for 1 hour is inadequate.

Paragraph 4.8.11.3--Hot oil test for 2 hours is inadequate.

No fluid immersion test is specified for hydraulic fluid.

No test for adhesion properties is specified after fluid exposure.

RECOMMENDATIONS

The revisions required to make this specification adequate are extensive, and providing them in detail is beyond the scope of this report. It is therefore recommended that this specification be revised to correct the noted deficiencies using MIL-T-9906 as a guide. The appropriate paragraphs are listed below.

Design Requirements

3.3--Physical Properties (Table I)

3.5.2--Fluid Resistance

Test Requirements

4.10.2--Adhesion

4.11--Fluid Resistance

4.11.1--Water (24 hours)

4.11.2--Jet Engine Fuel (72 hours)

4.11.3--Petroleum Base Hydraulic Oil (72 hours)

4.11.4--Nonpetroleum Base Hydraulic Fluid (72 hours)

4.11.5--Lubricating Oil at 200°F (24 hours)

NUMBER: MIL-T-8700A (1 May 70)

TITLE: General Specification for
Installation and Test of Electronic
Equipment in Aircraft

B--Inadequate

EVALUATION COMMENTS

This specification provides general guidelines and desirable characteristics of electronic installations. While this document cannot cover all possible design installation problems it does provide a comprehensive list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific design and test requirements.

Paragraph 3.3.1.6.1 specifies wiring in accordance with MIL-W-5088. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: Requirement specified but inadequate

Reliability: Requirement specified but inadequate

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and Electrical
Component Parts

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

Paragraph 3.4.3--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.9.1--Add the following before the existing sentence:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.14--Add the following to the existing sentence:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.2.2.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202 or MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.2.2--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specification for Airborne
Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for airborne electronic equipment for operation primarily in piloted aircraft. It is intended for use in incorporating in detail equipment specifications those requirements which are common to most airborne electronic equipment. The detail performance and test requirements for a particular equipment shall be as specified in the detail specification for that equipment.

Paragraph 3.1.16 specifies wire coding in accordance with MIL-STD-454, Requirement 20. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement inadequately specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 3.2.22--Revise existing sentence as follows:

Safety (personnel hazard). Provisions for personnel safety shall be in accordance with MIL-STD-454, Requirement 1, and MIL-STD-882.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-E-7080B (29 Apr 68)

TITLE: Selection and Installation of
Aircraft Electric Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for installation and selection of electrical equipment in piloted aircraft. While this document cannot cover specific design installation problems, it provides general guidelines and a list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific requirements.

Paragraph 3.2.1 specifies wiring in accordance with MIL-W-5088. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements
specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical and
Associated Equipment, General Specification
For

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 Systems Safety Program for Systems
and Associated Subsystems and Equip-
ment, Requirements For

Paragraph 3.1.8.2--Revise as follows:

Fire Hazard. Electric equipment installed in an environment having explosive vapors present shall conform to the requirements of the explosion-proof tests of Specification MIL-STD-810, Method 511.

Paragraph 3.1.8.7.2--Add the following to the existing paragraph:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.1.1.1--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1.8.1--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.1.8.7.4--Delete the existing paragraph and add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability.

The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.1.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.3--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-STD-454C (1 May 72)

9

TITLE: Standard General Requirements
for Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This standard covers common requirements to be used in military specifications for electronic equipment. It contains 67 requirements covering a broad scope of design and test considerations which are in turn further defined by applicable specifications. Requirements include such areas as safety, human factors, thermal design, moisture pockets, reliability and maintainability.

Requirement 20 defines internal hookup wire requirements and specifies identification coding in accordance with MIL-STD-681. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement 1 does not specify the applicable document for safety requirements.

TEST REQUIREMENTS: None

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Requirement 1, Paragraph 2--add the following:

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements For

Requirement 1, Paragraph 4--add the following to the existing paragraph:

Safety requirements shall be in accordance with
MIL-STD-882.

NUMBER: MIL-W-5088E (2 Jan 74)

10

TITLE: Selection and Installation
of Aircraft Wiring

B--Inadequate

EVALUATION COMMENTS

This specification covers the selection and installation of wiring and wiring devices for interconnection of electric and electronic equipment in aircraft. The following paragraphs are applicable to the subject problem.

Paragraph 3.7.1.3--Wire and Cable Identification--Aircraft
contractor shall identify each wire and cable . . .

Paragraph 3.7.1.3.3--Wire and Cable Marking--The characters
shall be legible and permanent and shall be printed on sleeves
at each end of wires too small to be imprinted directly.

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Environmental: No requirements specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS: None

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.10--Add the following:

Environmental Conditions. Equipment shall be capable of
satisfactory operation when subjected to the environ-
mental conditions specified in the system specification
of the procuring agency.

Paragraph 3.13--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.14--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

NUMBER: MIL-STD-681B (6 Feb 67)

11

TITLE: Identification Coding and
Application of Hookup and Lead
Wire

C--Not Applicable

EVALUATION COMMENTS

This standard establishes identification coding systems for all insulated hookup and lead wire used in electrical and electronic equipment used by the departments of the Army, Navy, and Air Force. Color or printed number codes are established for each of four systems and applications of each system are recommended.

Paragraph 5.4.3 specifies that coding of interconnecting wiring shall be in accordance with MIL-W-5088.

This document is considered adequate but is not directly applicable to the problem of deterioration of wiring identification tapes.

RECOMMENDATIONS: None

NUMBER: MIL-STD-1247B (20 Dec 68)

12

TITLE: Markings, Functions, and Hazard
Designations of Hose, Pipe, and
Tube Lines for Aircraft, Missile,
and Space Systems

A--Adequate

EVALUATION COMMENTS

This standard establishes requirements for positive identification of pipe, hose, and tube lines, including electrical conduits, used in aircraft, missile, and space systems. Identification of function, subsidiary function, hazards, direction of flow and pressure is specified by color and symbol codes as well as words. Media for identification include tape, bands, tags and paint.

Paragraph 4.2.1 specifies the use of tape conforming to MIL-T-9906 to identify the function of all lines, except those exposed to excessive heat (above 325°F) and lines in engine compartments, fuel tanks, and fuel cells where there is a possibility of tape being drawn into the engine intake or fuel screen.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-T-9906A (2 Mar 70)

TITLE: Aircraft Tubing Identification
Marker Tape (Non-Corrosive, Heat,
Cold, and Solvent Resistant)

A--Adequate

EVALUATION COMMENTS

This specification covers requirements for one type of printed, pressure-sensitive, noncorrosive identification tape which will withstand temperatures of +325°F and -320°F and is resistant to fuels, lubricating oils, and hydraulic fluids.

The following paragraphs apply to the subject problem

DESIGN REQUIREMENTS

- 3.1.2.1--Backing conforms to Federal Specification
L-T-100
- 3.3--Physical Properties (Table I)
- 3.5.2--Fluid Resistance
- 3.5.3--Heat Resistance

TEST REQUIREMENTS

- 4.10.2--Adhesion
- 4.11--Fluid Resistance
 - 4.11.1--Water (24 hours)
 - 4.11.2--Jet Engine Fuel (72 hours)
 - 4.11.3--Petroleum Base Hydraulic Oil (72 hours)
 - 4.11.4--Nonpetroleum Base Hydraulic Fluid (72 hours)
 - 4.11.5--Lubricating Oil at 200°F (24 hours)
- 4.12--Heat Resistance at 325°F (100 hours)

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: L-1-900 (3 Nov 65)

TITLE: Adhesive Pressure-Sensitive
Tape (Cellophane and Cellulose
Acetate)

C--Not Applicable

EVALUATION COMMENTS

This specification covers pressure-sensitive adhesive tapes used for mending, reinforcing, securing, shielding, and temporary identification. The primary application for this tape is for nonpermanent office use (Type I) and more permanent (long-aging) mending of books, papers, documents, maps, etc. (Type II).

RECOMMENDATIONS: None

NUMBER: L-T-99a (11 Sep 58)

15

TITLE: Pressure-Sensitive Adhesive
Identification Tape (Acetate-
Fiber)

C--Not Applicable

EVALUATION COMMENTS

This specification establishes requirements for a printable, pressure-sensitive, adhesive tape primarily intended for labeling, identification and edging applications. Type I is intended for use in short-term applications including files, containers, and charts; while Type II is intended for similar uses of a more permanent nature including edging of documents, maps, charts, etc., to protect them from tearing during handling and storage.

RECOMMENDATIONS: None

NUMBER: L-T-100a (30 Aug 60)

16

TITLE: Pressure Sensitive Adhesive
Polyester Film Tape

B--Inadequate

EVALUATION COMMENTS

This specification defines the requirements for pressure-sensitive tapes possessing a high degree of stability, solvent resistance, and designed for applications where the properties of polyester film are desirable. Type I is intended for use where a high degree of resistance to solvents, oils, and hydraulic fluids is required. Type II is intended for use where a weather-resistant long-aging label is required.

Paragraph 3.2 specifies testing of physical properties after immersion as follows:

- Distilled water--24 hours
- Jet Engine Fuel (MIL-F-5624, Grade JP-4)--72 hours
- Aromatic Fuel (MIL-H-3136, Type II)--24 hours
- Nonflammable Hydraulic Fluid (MIL-F-7083)--72 hours
- Nonflammable Aircraft Hydraulic Fluid (Skydrol 500)--72 hours

The following deficiencies exist:

DESIGN REQUIREMENTS

Paragraph 3.2--Physical Properties--Table 1 does not specify fluid immersion in Hydraulic Fluid (MIL-H-5606 and MIL-H-8446) or Lubricating Oils (MIL-L-7808 and MIL-L-23699).

TEST REQUIREMENTS

Paragraph 4.3.6--Adhesion After Immersion--Immersion in hydraulic fluid and lubricating oil is not specified.

RECOMMENDATIONS

The required revisions to make this specification adequate are extensive, and providing them in detail is beyond the scope of this report. It is therefore recommended that this specification be revised to correct the noted deficiencies using MIL-T-9906 as a guide. The following paragraphs are appropriate:

DESIGN REQUIREMENTS

- 3.3--Physical Properties (Table I)
- 3.5.2--Fluid Resistance
- 3.5.3--Heat Resistance

TEST REQUIREMENTS

- 4.10.2--Adhesion
- 4.11--Fluid Resistance
 - 4.11.1--Water (24 hours)
 - 4.11.2--Jet Engine Fuel (72 hours)
 - 4.11.3--Petroleum Base Hydraulic Oil (72 hours)
 - 4.11.4--Nonpetroleum Base Hydraulic Fluid (72 hours)
 - 4.11.5--Lubricating Oil at 200°F (24 hours)
- 4.12--Heat Resistance at 325°F (100 hours)

NUMBER: PPP-T-60D (25 Jun 71)

TITLE: Waterproof Packaging Tape

C--Not Applicable

EVALUATION COMMENTS

This specification covers the requirements for waterproof tape used for packaging applications. This tape is not considered applicable to the subject problem due to the restricted scope of its intended use.

RECOMMENDATIONS: None

NUMBER: PPP-T-66D (1 May 69)

18

TITLE: Pressure-Sensitive Adhesive,
Vinyl Plastic Film Tape

C--Not Applicable

EVALUATION COMMENTS

This specification establishes requirements for a plastic film pressure-sensitive adhesive tape designed for sealing against moisture. Tests for various moisture conditions are specified, but resistance to fuel, oil, hydraulic fluid, etc., is not required. The restricted scope of application of this tape makes it inapplicable to the subject problem.

RECOMMENDATIONS: None

APPENDIX II
INTERNAL AIRFLOW PATTERNS

POTENTIAL FIRE HAZARDS

GROUP: A

PROBLEM: Potential fire hazard with airflow from engine into fuselage

TABLE XX. SPECIFICATION REVIEW SUMMARY--FIRE HAZARDS					
Specification			Adequacy*		
Number	Title		A	B	C
1	MIL-STD-882 15 Jul 69	Requirements for System Safety Program for Systems and Associated Subsystems and Equipment	x		
2	AFSC DH 1-6 20 Jan 74	System Safety	x		
3	AFSC DH 1-X 15 Jan 74	Checklist of General Design Criteria, Chapter 6, System Safety	x		
4	MIL-HDBK-221 3 May 65	Fire Protection Design Handbook for U.S. Navy Aircraft Powered by Turbine Engines	x		
5	AMCP 706-203 Apr 72	Engineering Design Handbook--Helicopter Engineering, Part Three, Qualification Assurance	x		
6	MIL-F-7872C (ASG) 18 Nov 66	Test and Installation of Aircraft Continuous Fire and Overheat Warning Systems		x	
7	MIL-F-23447 (Wep) 14 Sep 62	Test and Installation of Radiation Sensing Type Aircraft Fire Warning Systems		x	
8	MIL-E-22285 (Wep) 27 Apr 60	Installation and Test of High-Rate-Discharge-Type Aircraft Fire Extinguishing Systems		x	
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: MIL-STD-882 (15 Jul 69)

TITLE: Requirements for System Safety Program A--Adequate
for Systems and Associated Subsystems
and Equipment

EVALUATION COMMENTS

This standard provides for uniform requirements and criteria for establishing and implementing system safety programs and guidelines for preparing system safety program plans (SSPP).

This standard is applicable to Department of Defense procurement of military systems during concept formulation, contract definition, engineering development, production, and operation.

DESIGN REQUIREMENTS

Paragraphs 3 through 6 provide hazard level definitions, general and detail requirements, and data requirements for system safety programs.

The subject problem area is specifically covered in paragraph 5.8.2.1, Preliminary Hazard Analysis, where it is stated:

Areas to be considered shall include but are not limited to the following:

- (a) Isolation of energy sources
- (b) Fuels and propellants
- (c) System environmental constraints
- (m) Fire ignition and propagation sources and protection

TEST REQUIREMENTS

Detailed test plans are specified in paragraph 7 to assure that safety is adequately demonstrated.

RECOMMENDATIONS

There are no recommendations for revision of this specification; however, reference to this standard should be made in all appropriate government specifications involving design, installation, and testing of weapon systems.

LE: System Safety

A--Adequate

EVALUATION COMMENTS

This design handbook is published by the Air Force Systems Command as a primary means of documenting and applying generalized technical design data in support of Air Force system and equipment development programs. The document provides general design criteria and guidance in a series of volumes, chapters, and design notes.

DESIGN REQUIREMENTS

Design Note 2A1 specifies MIL-STD-882 as the guide for a system safety program plan (SSPP).

Design Note 2B1 specifies sources of safety information.

Design Note 3N1 specifies general safety requirements in fire extinguishing and suppression systems; it defines and classifies fire zones and isolation factors such as fire walls, materials, skin structure, and air ducts.

Design 3N3 discusses fire causes and methods of prevention including MIL-HDBK-221, FIRE PROTECTION DESIGN HANDBOOK FOR U.S. NAVY AIRCRAFT POWERED BY TURBINE ENGINES.

Design Note 3M1 discusses fire hazard detection devices.

TEST REQUIREMENTS

Test requirements are treated in general terms believed adequate for a design handbook.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: AFSC DH 1-X (15 Jan 74)

3

TITLE: Checklist of General Design Criteria, A--Adequate
Chapter 6, System Safety

EVALUATION COMMENTS

This handbook contains checklists for each of the design handbooks in series 1-0 with chapters numbered according to the design handbooks to which they relate. For example, Chapter 6 is a checklist for DH 1-6, the system safety handbook. The checklists are intended for use by systems designers to ensure that all applicable design factors have been examined and all problems have been resolved or otherwise determined to be unimportant to the design. Items appropriate to the subject problem are:

- DN 6A4 - Propulsion System--engines
- DN 6A12- Protection Systems--hazard detection and warning devices
- DN 6A13- Fire Extinguishing and Suppression Systems

RECOMMENDATIONS

There are no recommendations for revision of this document.

TITLE: Fire Protection Design Handbook for A--Adequate
U.S. Navy Aircraft Powered by Turbine
Engines

EVALUATION COMMENTS

This handbook embodies requirements and design objectives for fire protection for all types of manned naval aircraft (including helicopters) with turbine engines.

DESIGN REQUIREMENTS

The comprehensive scope of this handbook is reflected in the following list of paragraphs pertinent to the subject problem:

- 2.4 Drainage, Ventilation, and Vents
 - 2.4.2 Ventilated areas
 - 2.4.3 Vent lines
 - 2.4.4 Vent and drain discharge
 - 2.4.6 Drainage in potential fire zones
 - 2.4.8 Ventilation configurations
- 2.10 Hazardous Systems
 - 2.10.2 High-speed rotating equipment
 - 2.10.2.1 Location
 - 2.10.2.3 Other hazards
 - 2.10.3.4 Explosion hazards
- 2.11 Potential Fire Zones
 - 2.11.1 Definition
 - 2.11.1.2 Fire-zone isolation
 - 2.11.1.2.1 Firewalls
 - 2.11.1.2.2 Skin and skin structure
 - 2.11.1.2.3 Air ducts
 - 2.11.1.3 Explosions
 - 2.11.1.4 Shutoff means
 - 2.11.1.11 Air inlets and outlets
 - 2.11.1.14 Fire detection
 - 2.11.1.15 Fire extinguishing
- 2.12 Fire Detection
 - Sections 2.12.1 through 2.12.6 fully describe detection systems requirements and reference specifications MIL-F-7872 and MIL-F-23447.

TEST REQUIREMENTS: Not Applicable

RECOMMENDATIONS

There are no recommendations for revision of this document.

While this handbook applies to Navy aircraft, it should be invoked in Army aircraft contracts until a comparable Army document is available. This handbook should be specified in applicable areas of the forthcoming AMCP 706-201 and -202 Army engineering design handbooks.

TITLE: Engineering Design Handbook--
Helicopter Engineering, Part Three,
Qualification Assurance

A--Adequate

EVALUATION COMMENTS

This document is the third volume of a three-part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and AMCP 706-202, DETAIL DESIGN. These documents are not reviewed since they are not yet formally released.

TEST REQUIREMENTS

This volume AMCP 706-203 defines the requirements for air worthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately upon specific tests and demonstrations of the complete helicopter system, air worthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups, and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification for that helicopter. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements.

Factors bearing on the subject problem are contained in the following paragraphs:

Paragraph 2-2.2.1--System safety applicable to the AQP

Paragraph 3-1--System safety program identified per MIL-STD-882 requirements

Paragraph 3-2.2--Safety analysis and hazard evaluation

Paragraph 3-2.3--Safety tests shall be included in test plans

Paragraph 5-2.1.3--Propulsion and power system mockup requirements include engine mounts, cowls, baffles, air intakes, firewalls, shrouds, etc.

Paragraph 9-3.2--Engine/airframe compatibility tests

Paragraph 9-3.3--Transmission and drives testing specifies:

For any helicopter, the test program shall demonstrate that the design requirements for performance, safety, reliability, and maintainability are met.

RECOMMENDATIONS

There are no recommendations for revision of this document.

It is recommended that the companion volumes be released as soon as possible to provide the necessary design guidance.

NUMBER: MIL-F-7872C (ASG) (18 Nov 66)

TITLE: Test and Installation of Aircraft B--Inadequate
Continuous Fire and Overheat
Warning Systems

EVALUATION COMMENTS

This specification describes requirements for the design, manufacture, testing, and installation of continuous type fire and overheat warning systems. These systems employ continuous lengths of heat-sensing elements connected to a monitoring device. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete the following:

MIL-E-5272 Environmental Testing, Aeronautical
and Associated Equipment, Aircraft,
General Specification for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements For

Paragraph 3.3.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency. Paragraphs 4.5.3 and 4.6.14 through 4.6.21 provide recommended test requirements.

Paragraph 3.3.2--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.5.16--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.5.17--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and over-haul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.5.3--Add the following to the existing paragraph:

Environmental Test Procedure. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.6.14--High Temperature

Delete: MIL-E-5272, Procedure II
Add: MIL-STD-810, Method 501

Paragraph 4.6.15--Low Temperature

Delete: MIL-E-5272, Procedure I
Add: MIL-STD-810, Method 502

Paragraph 4.6.16--High Altitude and Rate of Climb

Delete: MIL-E-5272, Procedure I
Add: MIL-STD-810, Method 512

Paragraph 4.6.17--Rain

Delete: MIL-E-5272, Procedure II
Add: MIL-STD-810, Method 506

Paragraph 4.6.18--Humidity

Delete: MIL-E-5272, Procedure I
Add: MIL-STD-810, Method 507

Paragraph 4.6.19--Vibration

Delete: MIL-E-5272, Procedure XII
Add: MIL-STD-810, Method 514

Paragraph 4.6.20--Salt Spray Test

Delete: MIL-E-5272, Procedure I
Add: MIL-STD-810, Method 509

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-F-28447 (wep) (14 Sep 62)

7

TITLE: Test and Installation of Radiation Sensing Type Aircraft Fire Warning Systems B--Inadequate

EVALUATION COMMENTS

This specification describes the requirements for the design, manufacture, testing and installation of radiation sensing (surveillance type) fire warning systems for use in aircraft. Deficiencies are as follows:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical and Associated Equipment, General Specifications for

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipments)

MIL-STD-785 Reliability Program for System and Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment, Requirements For

Paragraph 3.4.5.1--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.9--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.4.21--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.6.3--Delete the existing paragraph and add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.5.4--Add the following to the existing paragraph.

Environmental Test Procedure. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.6.19--High Temperature Test

Delete: MIL-E-5272, Procedure II

Add: MIL-STD-810, Method 501

Paragraph 4.6.20--Low Temperature Test

Delete: MIL-E-5272, Procedure I

Add: MIL-STD-810, Method 502

Paragraph 4.6.21--High Altitude and Rate of Climb

Delete: MIL-E-5272, Procedure I

Add: MIL-STD-810, Method 512

Paragraph 4.6.23--Rain Test

Delete: MIL-E-5272, Procedure II

Add: MIL-STD-810, Method 506

Paragraph 4.6.24--Vibration Test

Delete: MIL-E-5272, Procedure XII

Add: MIL-STD-810, Method 514

Paragraph 4.6.25--Salt Spray Test

Delete: MIL-E-5272, Procedure I

Add: MIL-STD-810, Method 509

Paragraph 4.6.26--Humidity Test

Delete: MIL-E-5272, Procedure I

Add: MIL-STD-810, Method 507

Paragraph 4.6.27--Fungus Resistance

Delete: MIL-E-5272, Procedure I

Add: MIL-STD-810, Method 508

Paragraph 4.6.29--Explosion Tests

Delete: MIL-E-5272, Procedure IV

Add: MIL-STD-810, Method 511

Paragraph 4.3.2.2--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Installation and Test of High-Rate-Discharge-Type Aircraft Fire Extinguishing System B--Inadequate

EVALUATION COMMENTS

This specification covers requirements for installation and test of the high-rate-discharge type of fixed fire extinguishing systems for engine spaces and other potential fire zones in aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirement specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirement specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems and
Associated Subsystems and Equipment,
Requirements For

Paragraph 3.x--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.x.x--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures, or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.x.x--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.x.x--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

COCKPIT AIR CONTAMINATION

GROUP: B

PROBLEM: Smoke and dust contamination in cockpit due to reverse airflow

TABLE XXI. SPECIFICATION REVIEW SUMMARY-- COCKPIT AIR CONTAMINATION						
Specification				Adequacy*		
Number		Title	A B C			
1	MIL-STD-882 15 Jul 69	Requirements for System Safety Program for Systems and Associated Subsystems and Equipment	x			
2	USAF Spec. Bull. 526a 19 Apr 67	Maximum Allowable Concentration of Cabin Air Contaminants	x			
3	MIL-H-18325B (Aer) 4 May 59	General Specification for Aircraft Heating and Ventilating Systems			x	
4	AMCP706-203 Apr 72	Engineering Design Handbook-- Helicopter Engineering Qualification Assurance, Chapter 8 Helicopter Surveys	x			
5	MIL-T-18606 (AS) 31 Oct 69	Test Procedures for Aircraft Environmental Systems	x			
6	MIL-STD-800 21 Jul 58	Procedure for Carbon Monoxide Detection and Control in Aircraft	x			
*A--Adequate B--Inadequate C--Not Applicable						

NUMBER: MIL-STD-882 (15 Jul 69)

1

TITLE: Requirements for System Safety
Program for Systems and Associ-
ated Subsystems and Equipment

A--Adequate

EVALUATION COMMENTS

This standard provides for uniform requirements and criteria for establishing and implementing system safety programs and guidelines for preparing system safety program plans (SSPP).

This standard is applicable to Department of Defense procurement of military systems during concept formulation, contract definition, engineering development, production, and operation.

DESIGN REQUIREMENTS

Paragraphs 3 through 6 provide hazard level definitions, general and detail requirements, and data requirements for system safety programs.

The subject problem area is specifically covered in paragraph 5.8.2.1, Preliminary Hazard Analysis, where it is stated:

Areas to be considered shall include but are not limited to the following:

- (a) Isolation of energy sources
- (c) System environmental constraints
- (l) Life support requirements
- (m) Fire ignition and propagation sources and protection

TEST REQUIREMENTS

Detailed test plans are specified in paragraph 7 to assure that safety is adequately demonstrated.

RECOMMENDATIONS

There are no recommendations for revision of this specification; however, reference to this standard should be made in all appropriate government specifications involving design, installation, and test of weapon systems.

NUMBER: USAF Specification Bulletin No. 526a

2

TITLE: Maximum Allowable Concentration of Cabin Air Contaminants A--Adequate

EVALUATION COMMENTS

This bulletin gives limits of acceptable toxic substances, in parts per million, to which personnel may be exposed on an 8-hour-per-day basis.

Smoke normally includes gases such as carbon monoxide and carbon dioxide plus particulate matter dependent upon material burning.

Paragraph 1 states:

The airframe contractor shall determine which contaminants may be present in the air going to the occupied compartments, . . . The contractor shall select an approved method of testing to determine whether the concentration of these contaminants within the occupied compartments is within the safe limits specified.

Paragraph 3 Requirements, adequately describes the airframe and engine contractors responsibility to assure that toxic levels specified are not exceeded.

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-H-18325B (Aer) (4 May 59)

3

TITLE: General Specification for
Aircraft Heating and Ventilating
Systems

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for aircraft environmental systems. Paragraph 3.14.6 defines ventilation requirements under flight conditions as specified in MIL-T-18606, paragraph 4.2.2.7, which are adequate to prevent the subject problem. The following specification deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: No requirement specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: No requirement specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.2.3--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.2.4--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.2.1.1--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.2.2.1--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel or operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.2.1--Add the following:

Environmental Testing. Equipment shall be subjected to environment testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.2--Add the following:

Reliability and Maintainability Demonstration.

Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: AMCP 706-203 (Apr 72)

4

TITLE: Engineering Design Handbook--
Helicopter Engineering, Part 3,
Qualification Assurance

A--Adequate

EVALUATION COMMENTS

This document is the third volume of a three part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and in AMCP 706-202, DETAIL DESIGN. These documents are not reviewed since they are not yet formally released.

TEST REQUIREMENTS

This volume, AMCP 706-203, defines the requirement for airworthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately upon specific tests and demonstrations of the complete helicopter system, airworthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups, and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification for that particular helicopter. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements.

Factors bearing on the subject problem are contained in the following paragraphs:

Paragraph 8-8.1--Crew Environmental Survey, gives general plan and test requirements to verify control system adequacy.

Paragraph 8-8.3--Test Requirements, includes air supply toxicity and emergency smoke removal.

Paragraph 8-8.3.1--Ground tests for compartment contamination levels not to exceed limits specified in U.S. Air Force Specification Bulletin 526 and MIL-STD-800

Paragraph 9-10.2.2--Crew station environmental control system qualification to be demonstrated per paragraph 8-8

Paragraph 9-10.2.4--Toxicology demonstration to show levels do not exceed USAF Specification Bulletin 526.

Paragraph 9-10.4--Environmental Control Systems, specifies demonstrations per MIL-H-18325 and MIL-T-18606 including smoke or gas removal procedures.

RECOMMENDATIONS

There are no recommendations for revision of this handbook.

It is recommended that the companion volumes be released as soon as possible to provide the necessary design guidance.

NUMBER: MIL-T-18606 (AS) (31 Oct 69)

5

TITLE: Test Procedures for Aircraft
Environmental Systems

A--Adequate

EVALUATION COMMENTS

This specification covers testing of aircraft environmental systems to demonstrate safety and satisfactory performance.

DESIGN REQUIREMENTS: Not applicable

TEST REQUIREMENTS

Paragraph 3.2.2 states that smoke or gas removal procedures shall be demonstrated to assure that areas occupied by passengers or crew will be cleared of smoke or gas in a safe period of time.

Paragraph 4.2.1.1 specifies that smoke removal procedures shall be satisfactorily demonstrated and recorded.

Paragraph 4.2.2.7 requires that data be recorded to show satisfactory capacity of cabin ventilating systems under the most critical combination of altitude and speed (see MIL-H-18325 Paragraph 3.14.6)

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: MIL-STD-800 (21 Jul 58)

6

TITLE: Procedure for Carbon Monoxide
Detection and Control in Aircraft

A-- Adequate

EVALUATION COMMENTS

This specification defines maximum levels of toxicity and how to measure such levels in ground and flight tests.

DESIGN REQUIREMENTS: Not applicable

TEST REQUIREMENTS

Paragraph 4.1 specifies test equipment and procedures.

Paragraph 5.1.1.1 defines maximum concentration in occupied areas.

Paragraph 5.1.1.2 defines the allowable increase in the maximum concentration for transient conditions.

RECOMMENDATIONS

There are no recommendations for revision of this document.

APPENDIX III
TEMPERATURE OR THERMAL SHOCK

ELECTRICAL/ELECTRONIC COMPARTMENT

GROUP: A

PROBLEM: Overheating in electrical/electronic compartment

TABLE XXII. SPECIFICATION REVIEW SUMMARY-- ELECTRONIC EQUIPMENT					
Specification			Adequacy*		
Number	Title		A	B	C
1	MIL-I-8700A 1 May 70	General Specification for Instal- lation and Test of Electronic Equipment in Aircraft		x	
2	MIL-E-5400P 2 Jul 73	General Specification for Airborne Electronic Equipment		x	
3	MIL-E-7030B 29 Apr 68	Selection and Installation of Aircraft Electrical Equipment		x	
4	MIL-STD-454C 1 May 72	Standard General Requirements for Electronic Equipment		x	
5	MIL-STD-202E 16 Apr 73	Test Methods for Electronic and Electrical Component Parts	x		
6	MIL-T-5422F (AS) 30 Nov 71	Environmental Testing of Air- borne Electronic and Associated Equipment	x		
7	MIL-T-23103A 29 Apr 71	General Requirements for Thermal Performance Evaluation of Airborne Electronic Equipment and Systems	x		
8	AMCP 706-203 Apr 72	Engineering Design Handbook-- Helicopter Engineering, Part Three, Qualification Assurance	x		
9	MIL-STD-108E 4 Aug 66	Definitions of and Basic Require- ments for Enclosures for Electric and Electronic Equipment	x		
*A--Adequate B--Inadequate C--Not Applicable					

TABLE XXII - Continued					
Specification			Adequacy*		
Number	Title		A	B	C
10	SCL-I-0019B 1 Apr 65	Installation of Radio Set AN/ARC-54() in Army Aircraft		x	
11	SCL-I-0020 20 Apr 64	Installation of Radio Set AN/ARC-51()X in Army Aircraft		x	
12	SCL-I-0053A 27 Oct 66	Installation of (VHF) Radio Set AN/ARC-134() (Wilcox 807A) in Army Aircraft		x	
13	SCL-T-0019B 1 Apr 65	Bench, Preflight, and Flight Testing of Radio Set AN/ARC-54() for Army Aircraft		x	
14	SCL-T-0020 20 Apr 64	Bench, Preflight, and Flight Testing of Radio Set AN/ARC- 51()X for Army Aircraft		x	
15	SCL-T-0053B 30 Nov 66	Bench, Preflight, and Flight Testing of (VHF) Radio Set AN/ARC-134() (Wilcox 807A) for Army Aircraft		x	
*A--Adequate B--Inadequate C--Not Applicable					

NUMBER: MIL-1-8700A (1 May 70)

1

TITLE: General Specification for Installation and Test of Electronic Equipment in Aircraft B--Inadequate

EVALUATION COMMENTS

This specification provides general guidelines and desirable characteristics of electronic installations. While this document cannot cover all possible design installation problems, it does provide a comprehensive list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific design and test requirements.

Paragraph 3.3.7 specifies cooling requirements. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: Requirement inadequately specified

Reliability: Requirement inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

MIL-STD-470 Maintainability Program Requirements (For Systems and Equipment)

MIL-STD-785 Reliability Program for System and Equipment Development and Production

MIL-STD-810 Environmental Test Methods

Paragraph 3.4.3--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.3.9.1--Add the following prior to existing sentence:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.3.14--Add the following to the existing sentence:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.3.15--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.2.2.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202 or MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.2.2--Add the following

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: General Specifications for
Airborne Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for airborne electronic equipment for operation primarily in piloted aircraft. It is intended for use in incorporating in detail equipment specifications those requirements which are common to most airborne electronic equipment. The detail performance and test requirements for a particular equipment shall be as specified in the detail specification for that equipment.

Paragraph 3.2.5 specifies thermal design in accordance with MIL-STD-454, Requirement 52. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement inadequately specified

TEST REQUIREMENTS

Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 3.2.2.2--Revise existing sentence as follows:

Safety (personnel hazard). Provisions for personnel safety shall be in accordance with MIL-STD-454, Requirement 1, and MIL-STD-882.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.3.4--Add the following:

Reliability and Maintainability Demonstration.
Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-E-7080B (29 Apr 68)

3

TITLE: Selection and Installation of
Aircraft Electric Equipment

B--Inadequate

EVALUATION COMMENTS

This specification covers general requirements for installation and selection of electrical equipment in piloted aircraft. While this document cannot cover specific design installation problems, it provides general guidelines and a list of applicable documents which are referenced in the appropriate paragraphs. These documents in turn cover more specific requirements.

Paragraph 3.1.8.7.2 specifies environmental protection requirements including forced-air cooling, if necessary. Paragraph 4.5 specifies temperature checks. The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: Requirements inadequately specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Environmental: Requirements inadequately specified

Reliability and Maintainability: No demonstration requirements specified.

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Specifications, Military, delete:

MIL-E-5272 Environmental Testing, Aeronautical and
Associated Equipment, General Specification For

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipments)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-810 Environmental Test Methods

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.1.8.2--Revise as follows:

Fire Hazard. Electric equipment installed in an environment having explosive vapors present shall conform to the requirements of the explosion-proof tests of Specification MIL-STD-810, Method 511.

Paragraph 3.1.8.7.2--Add the following to the existing paragraph:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.1.1.1--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.1.8.1--Delete the existing paragraph and add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.1.8.7.4--Delete the existing paragraph and add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 4.1.1--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-810. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 4.2.3--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: MIL-STD-454C (1 May 72)

4

TITLE: Standard General Requirements
for Electronic Equipment

B--Inadequate

EVALUATION COMMENTS

This standard covers common requirements to be used in military specifications for electronic equipment. It contains 67 requirements covering a broad scope of design and test considerations which are in turn further defined by applicable specifications. Requirements include such areas as safety, human factors, moisture pockets, reliability and maintainability. Thermal design requirements are specified in Requirement 52. The following deficiencies exist:

DESIGN REQUIREMENTS

Safety: Requirement 1 does not specify the applicable document for safety requirements.

TEST REQUIREMENTS: None

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Requirement 1, Paragraph 2--Add the following:

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Requirement 1, Paragraph 4--Add the following to the existing paragraph:

Safety requirements shall be in accordance with
MIL-STD-882.

TITLE: Test Methods for Electronic and
Electrical Component Parts

A--Adequate

EVALUATION COMMENTS

This standard establishes uniform methods for testing electronic and electrical component parts, including environmental tests to determine resistance to deleterious effects of natural elements and conditions surrounding military operations. The term component parts includes such items as capacitors, resistors, switches, relays, transformers, and jacks.

The requirements which must be met by these component parts are specified in the detail product specifications, and they must be tested accordingly using the methods as described herein.

Method 107 provides thermal shock tests more comprehensive than that given in either MIL-STD-810 or MIL-T-5422. The tests are considered adequate.

Method 108 provides tests for life at elevated ambient temperature which are considered adequate.

RECOMMENDATIONS

This standard is preferred for testing of electrical and electronic equipment, since it is a DoD document and is more comprehensive than MIL-T-5422, which is a Navy document.

NUMBER: MIL-T-5422F (AS) (30 Nov 71)

6

TITLE: Environmental Testing Of Airborne
Electronic and Associated Equipment

A--Adequate

EVALUATION COMMENTS

This is a Navy Department specification which contains procedures for testing airborne electronic and associated equipment under environmental conditions to demonstrate compliance with MIL-E-5400, MIL-T-21200, other general design specifications, and applicable detailed equipment specifications.

Paragraph 3.2 states:

If the detail equipment specification modifies these limits or conditions (environmental), the limits or conditions specified herein shall be modified to correspond to the limits or conditions specified in the detail equipment specification.

This document contains 14 test procedures, of which 9 are roughly comparable to MIL-STD-810B but are oriented to Navy airborne electronic equipment.

RECOMMENDATIONS

There are no recommendations for revision of this document. However, it should be considered a nonpreferred specification for U.S. Army aircraft in deference to the more comprehensive MIL-STD-202.

NUMBER: MIL-T-23103A(AS) (29 Apr 71)

7

TITLE: General Requirements for Thermal
Performance Evaluation of Airborne
Electronic Equipment and Systems

A--Adequate

EVALUATION COMMENTS

This specification is intended to provide standard procedures for subjecting airborne electronic equipment to simulated thermal environments for the purpose of evaluating the thermal performance. The following paragraphs are pertinent:

Paragraph 3.1--General Requirements--Contractor shall establish a comprehensive thermal design and evaluation program based on periodic acquisition and reporting of standardized thermal performance limit and evaluation data throughout all phases of development.

Paragraph 3.2.1--Thermal Environmental Parameters

Paragraph 3.2.2--Thermal Evaluation Requirements

Paragraph 3.2.3--Simulated Environment--Tests will duplicate as closely as possible the airframe mounting and flight mission environmental conditions

RECOMMENDATIONS

There are no recommendations for revision of this document.

TITLE: Engineering Design Handbook--
Helicopter Engineering, Part
Three, Qualification Assurance

A--Adequate

EVALUATION COMMENTS

This document is the third volume of a three-part engineering design handbook series intended to provide technical guidance for helicopter designers in both the industry and the Army.

DESIGN REQUIREMENTS

Requirements are delineated in AMCP 706-201, PRELIMINARY DESIGN, and in AMCP 706-202, DETAIL DESIGN. These documents are not reviewed, since they are not yet formally released.

TEST REQUIREMENTS

This volume, AMCP 706-203, defines the requirement for airworthiness qualification of the helicopter and for demonstration of contract compliance. Although dependent ultimately on specific tests and demonstrations of the complete helicopter systems, airworthiness qualification is a continuing process beginning with initial system development and continuing through design reviews, mockups, and test planning. Both contractor and government test requirements are specified in this document.

Mandatory requirements are identified by the word *shall* but are not binding for a specific helicopter program except as specified in the RFP or system specification for that particular helicopter. This handbook will not be referenced in a contract but will be used as a basis for establishing contractual requirements. Factors bearing on the subject problem are contained in the following paragraphs:

Paragraph 9.7.4--Communication Equipment

Paragraph 9.7.4.2.2--Airworthiness Qualification Ground Tests

Paragraph 9.7.4.2.2.2--Cooling tests are specified to establish and record maximum compartment temperature for each communication set both on the ground and in flight.

Paragraph 9.7.4.2.2.6--Maintainability tests

Paragraph 9.7.5--Navigation Equipment

Paragraph 9.7.5.2.2.2--Cooling tests are specified as above

RECOMMENDATIONS

There are no recommendations for revision of this handbook.

NUMBER: MIL-STD-108E (4 Aug 66)

9

TITLE: Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment

A--Adequate

EVALUATION COMMENTS

This standard establishes definitions and basic requirements for enclosures for the environmental protection of electrical and electronic equipment.

DESIGN REQUIREMENTS

Environmental: Defined as required

Safety, Reliability, and Maintainability: Not applicable

TEST REQUIREMENTS

Environmental: Defined or referenced to MIL-STD-810 as required

RECOMMENDATIONS

There are no recommendations for revision of this document.

NUMBER: SCL-I-0019B (1 Apr 65)

10

TITLE: Installation of Radio Set
AN/ARC-54() in Army Aircraft

B--Inadequate

EVALUATION COMMENTS

This document provides instructions for installing the AN/ARC-54() radio set and its associated components in U.S. Army aircraft. It requires installation in accordance with MIL-I-8700, and paragraph 3.3 defines environmental requirements which include:

Temperature (operating): -40° to +132°F. Note:
Operable from +132°F to 150°F with no measurement degradation of more than a factor of two
(2).

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and
Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Not applicable (See SCL-T-0019)

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.x.x--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information

shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.X.X--Add the following

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.X.X--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

NUMBER: SCL-I-0020 (20 Apr 64)

11

TITLE: Installation of Radio Set AN/ARC-51()X in Army Aircraft

B--Inadequate

EVALUATION COMMENTS

This document provides engineering design instructions for installing the AN/ARC-51()X radio set and its associated components in U.S. Army aircraft. It requires compliance with MIL-I-8700, and paragraph 3.3 specifies environmental requirements which include:

Temperature: -55°C to +71°C (Intermittent operation and 30 minutes continuous operation at 71°C when supplied with cooling air from attached Electronic Equipment Cooler).

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Not applicable (See SCL-T-0020)

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.x.x--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information

shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.x.x--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.x.x--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

NUMBER: SCL-I-0053A (27 Oct 66)

12

TITLE: Installation of Radio Set AN/ARC- B--Inadequate
134() (Wilcox 807A) in Army Aircraft

EVALUATION COMMENTS

This document covers the technical instructions for the installation of radio set AN/ARC-134() (Wilcox 807A) (VHF) and associated components in aircraft. It requires compliance with MIL-I-8700, and the following systems limitations are specified in paragraph 3.3:

This equipment is designed to operate over a temperature range of -54°C to +55°C (-67°F to +131°F) at altitudes up to 28,000 feet when operated on a continuous duty basis.

The following deficiencies exist:

DESIGN REQUIREMENTS

Applicable Documents: Paragraph 2.1, Specifications and Standards

Environmental: Requirements inadequately specified

Safety: No requirement specified

Reliability: No requirement specified

Maintainability: No requirement specified

TEST REQUIREMENTS

Not applicable (See SCL-T-0053)

RECOMMENDATIONS FOR DESIGN REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-470 Maintainability Program Requirements
(For Systems and Equipment)

MIL-STD-785 Reliability Program for System and
Equipment Development and Production

MIL-STD-882 System Safety Program for Systems
and Associated Subsystems and
Equipment, Requirements For

Paragraph 3.x--Add the following:

Environmental Conditions. Equipment shall be capable of satisfactory operation when subjected to the environmental conditions specified in the system specification of the procuring agency.

Paragraph 3.x.x--Add the following:

Safety. Systems and components shall be designed to provide a maximum of safety to personnel during the course of installation and preflight testing. Adequate precautionary warnings and information shall be affixed to components when considered essential and shall be supplied with installation, maintenance, and operating instructions. Provisions shall be made to prevent personnel from being accidentally subjected to injurious voltages or current, pressures, temperatures or movements of components. Safety requirements shall be in accordance with MIL-STD-882.

Paragraph 3.x.x--Add the following:

Reliability. Reliability of equipment furnished under this specification shall be that which is necessary to achieve the required mission and system reliability. Equipment installation shall provide for standardization and simplicity of operation as long as reliability is not adversely affected. Reliability requirements shall be in accordance with MIL-STD-785, and as specified in the system specification.

Paragraph 3.x.x--Add the following:

Maintainability. The availability and maintenance man-hours per flight hour required of the subsystem or component shall be that which is necessary to achieve the required system inherent and achieved availability. The item shall be capable of disassembly, reassembly, service maintenance, and inspection with Federally stocked tools and equipment. Designs requiring specially designed maintenance tools and equipment shall be avoided. The item shall be constructed so that adjustments and repairs of field-adjustable components can easily be made by personnel of operating units and overhaul bases. The equipment shall meet the requirements of MIL-STD-470.

NUMBER: SCL-T-0019B (1 Apr 65)

13

TITLE: Bench, Preflight, and Flight Testing of Radio Set AN/ARC-54() for Army Aircraft B--Inadequate

EVALUATION COMMENTS

This technical instruction covers methods and procedures for accomplishing the necessary performance and operational tests on radio set AN/ARC-54, both before and after installation in prototype and production aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Not applicable (See SCL-I-0019)

TEST REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and
Electrical Component Parts

Paragraph 3.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

TITLE: Bench, Preflight, and Flight Testing of Radio Set AN/ARC-51()X for Army Aircraft B--Inadequate

EVALUATION COMMENTS

This document provides instructions and methods for performing bench and engineering preflight and flight tests on radio set AN/ARC-51()X both before and after installation in a prototype aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Not applicable (See SCL-I-0020)

TEST REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirement specified

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and
Electrical Component Parts

Paragraph 3.x--Add the following:

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

NUMBER: SCL-T-0053B (30 Nov 66)

15

TITLE: Bench, Preflight and Flight Testing of (VHF) Radio Set AN/ARC-134() (Wilcox 807A) for Army Aircraft B--Inadequate

EVALUATION COMMENTS

This document provides instructions and methods for performing bench and engineering preflight and flight tests of radio set An/ARC-134() (Wilcox type 807A), both before and after installation in a prototype aircraft. The following deficiencies exist:

DESIGN REQUIREMENTS

Not applicable (See SCL-I-0053)

TEST REQUIREMENTS

Applicable Documents: Paragraph 2.1, Standards, Military
Environmental: Requirements inadequately specified
Reliability and Maintainability: No demonstration requirements specified

RECOMMENDATIONS FOR TEST REQUIREMENTS

Paragraph 2.1--Under Standards, Military, add:

MIL-STD-202 Test Methods for Electronic and
Electrical Component Parts

Paragraph 3.x--Add the following

Environmental Testing. Equipment shall be subjected to environmental testing in accordance with MIL-STD-202. Specific test parameters shall be in accordance with the applicable system specification.

Paragraph 3.x.x--Add the following:

Reliability and Maintainability Demonstration. Tests shall be performed to demonstrate compliance with reliability and maintainability program goals. The demonstration shall be performed in accordance with an approved test plan established by the system specification.

Acceptance Criteria. Quantitative reliability and maintainability requirements in terms of failure rate, downtime, and maintenance man-hours as established in the test plan must be met or exceeded for acceptance.

APPENDIX IV
CLEANING MATERIALS AND TECHNIQUES

This induced environmental factor did not include problems of sufficient weight (see Table VIII) to warrant document review. However, the problem of airframe moisture corrosion, as discussed in the section on definitions, is directly related to preventive measures which include cleaning materials and techniques.

The documents reviewed for airframe corrosion include the GENERAL AIRCRAFT MAINTENANCE MANUAL, TM 55-1500-204-25/1, which provides appropriate cleaning materials and techniques for maintenance personnel. The document as reviewed in Appendix I B-1 is considered adequate for this purpose.

APPENDIX V
ANIMAL FLUIDS AND SECRETIONS

This induced environmental factor did not include problems of sufficient weight (Table VIII) to warrant document review. However, as discussed in the section on definitions, the failure modes resulting from this factor are generally indistinguishable, at least in data, from other airframe corrosion causal factors.

The documents reviewed for airframe corrosion preventive measures are therefore considered appropriate to this environmental factor, as reviewed in Appendix I B-1.

APPENDIX VI
DOCUMENTS ANALYZED

The documents analyzed in this study are listed in Table XXIII in numerical order. The page number listed with each document is the page on which the review summary for that document appears.

TABLE XXIII. DOCUMENTS ANALYZED		
Number	Title	Page
<u>MILITARY SPECIFICATIONS</u>		
1 MIL-W-1511A 20 Feb 64	Steel (Carbon) Preformed Flexible Wire Rope	142
2 MIL-S-3786D 7 Jun 73	General Specification for Rotary Switches (Circuit Selector, Low-Current Capacity)	173
3 MIL-S-3950E 21 Sep 73	Environmentally Sealed Toggle Switches	179
4 MIL-B-3990B 11 Dec 68	Airframe Antifriction Needle Roller Bearings	78
5 MIL-S-5002C 26 Jul 71	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapon Systems	151
6 MIL-S-5049B 21 Dec 66	Piston Rod Scrapers	117
7 MIL-W-5088E 2 Jan 74	Installation of Aircraft Wiring	206
8 MIL-E-5272C (ASG) 22 Jan 71	General Specification for Environmental Testing of Aeronautical and Associated Equipment	90
9 MIL-E-5400P 2 Jul 73	General Specification for Airborne Electronic Equipment	163, 201 250
10 MIL-T-5422F (AS) 30 Nov 71	Environmental Testing of Airborne Electronic and Associated Equipment	169, 256

TABLE XXIII - Continued		
Number	Title	Page
11 MIL-B-5423B 3 Feb 72	General Specification for Dust and Water Seal Boots (for Toggle and Pushbutton Switches, Circuit Breakers, and Rotary Actuated Parts)	159
12 MIL-W-5424B 10 Jan 72	Steel (Corrosion-Resisting) Preformed Flexible Wire Rope (for Aeronautical Use)	136
13 MIL-H-5440F 18 Jan 72	Design and Installation Requirements for Aircraft Types I and II Hydraulic Systems	102
14 MIL-C-5503C 26 Apr 72	General Requirements for Aeronautical Hydraulic Actuating Cylinders	114
15 MIL-G-5514F 15 Jan 69	General Requirements for Design of Glands and Hydraulic Packings	120
16 MIL-P-5516C 29 Mar 71	Petroleum Hydraulic Fluid Resistant Preformed Packing, 160°F	121
17 MIL-P-5518C 3 Dec 68	Design, Installation, and Data Requirements For Aircraft Pneumatic Systems	108
18 MIL-T-5522C 25 Mar 66	General Test Procedure for Aircraft Hydraulic and Pneumatic Systems	128
19 MIL-B-5628 26 Jul 51	Airframe Plain Bearings	55
20 MIL-B-5629 28 Feb 50	Airframe Plain Rod-End AN943, AN947, and AN949 Bearings	56
21 MIL-B-5687C 12 Jun 62	Oil-Impregnated Sintered Metal-Powder Sleeve Bearings and Thrust Washers	81
22 MIL-T-5955C 17 Sep 70	General Requirements for VTOL-STOL Transmission Systems	99
23 MIL-B-6038A 28 Mar 61	Airframe Antifriction Bellcrank Ball Bearings	69

TABLE XXIII - Continued		
Number	Title	Page
24 MIL-B-6039C 7 Jul 71	Self-Aligning Antifriction Sealed Rod-End Double-Row Ball Bearings	72
25 MIL-W-6729A 10 Sep 62	General Specification for Testing Watertightness of Aircraft	156
26 MIL-S-6807D 25 Sep 68	General Specification for Selector Power Rotary Switches	176
27 MIL-E-7080B 29 Apr 68	Selection and Installation of Aircraft Electrical Equipment	164, 202 251
28 MIL-F-7179E 15 Nov 72	General Specification for Fin- ishes and Coatings for Protection of Aerospace Weapons Systems, Structures, and Parts	145, 150
29 MIL-C-7439 24 Feb 72	Rain Erosion Resistant and Rain Erosion Resistant with Anti- Static Treatment Elastomeric Coat- ing System for Exterior Aircraft and Missile Plastic Parts	153
30 MIL-R-7575C 9 Jun 72	Low-Pressure Laminating Polyester Resin	154
31 MIL-F-7872C (ASG) 18 Nov 66	Test and Installation of Aircraft Continuous Fire and Overheat Warn- ing Systems	225
32 MIL-B-7949D 8 Dec 71	Airframe Antifriction Ball Bearings	75
33 MIL-P-8564D 18 Nov 70	General Specification for Aero- nautical Pneumatic System Components	111
34 MIL-D-8634B 12 Oct 71	Identification Markers	192
35 MIL-D-8635B 30 Jun 71	Decals for Use on Interior Surfaces	193
36 MIL-T-8679 5 Mar 54	Helicopter Ground Test Requirements	124

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Number	Title	Page
37 MIL-I-8700A 1 May 70	General Specification for Installation and Test of Electronic Equipment in Aircraft	160, 198 247
38 MIL-H-8775C 8 Jan 64	General Specification for Aircraft and Missile Hydraulic System Components	105
39 MIL-R-8791C 29 Jun 64	Tetrafluoroethylene Resin Hydraulic and Pneumatic Packing Retainer	122
40 MIL-S-8805C 22 May 72	General Specification for Sensitive and Push (Snap Action) Switches and Switch Assemblies	182
41 MIL-H-8890 1 Nov 61	General Specification for Type III Hydraulic Components (-65° to 450°F)	131
42 MIL-H-8891 1 Nov 61	Design, Installation, and Data Requirements for Type III Manned Flight Vehicle Hydraulic Systems	130
43 MIL-B-8942 (ASG) 14 Aug 67	Self-Aligning TFE-Lined Plain Bearings (-65°F to +250°F)	57
44 MIL-B-8948A 30 Nov 72	Self-Aligning TFE-Lined Rod-End Plain Bearings (-65°F to +250°F)	60
45 MIL-R-9300B 15 Jan 68	Low-Pressure Laminating Epoxy Resin	155
46 MIL-S-9395D 11 Apr 73	General Specification for Pressure Switches (Absolute, Gauge, and Differential)	171
47 MIL-F-9490C (USAF) 9 Mar 66	General Specification for Design, Installation, and Test of Piloted Aircraft Flight Control Systems	49, 94 133
48 MIL-T-9906A 2 Mar 70	Aircraft Tubing Identification Marker Tape (Non-Corrosive, Heat, Cold, and Solvent Resistant)	210
49 MIL-C-11796B 17 Nov 61	Hot Application Petrolatum Corrosion Preventive Compound	146

TABLE XXIII - Continued

Number	Title	Page
50 MIL-C-16173D 19 Nov 68	Cold-Application Solvent Cutback Corrosion Preventive Compound	147
51 MIL-C-18244A (WEP) 1 Dec 62	General Specification for Automatic Piloted Aircraft Control and Stab- ilization Systems	96
52 MIL-F-18264D 23 Apr 71	Application and Control of Weapons System Organic Finishes	152
53 MIL-H-18325B (Aer) 4 May 59	General Specification for Aircraft Heating and Ventilating Systems	140
54 MIL-F-18372 (AER) 31 Mar 55	General Specification for Design, Installation, and Test of Aircraft Flight Control Systems	52, 95 134
55 MIL-C-18375A (ASG) 30 Aug 62	Steel (Corrosion-Resisting, Non- Magnetic) Preformed Flexible Cable (For Aeronautical Use)	139
56 MIL-T-18606 (AS) 31 Oct 69	Test Procedures for Aircraft Environmental Systems	243
57 MIL-E-22285 (Wep) 27 Apr 60	Installation and Test of High- Rate-Discharge-Type Aircraft Fire Extinguishing Systems	231
58 MIL-T-23103A 29 Apr 71	General Requirements for Thermal Performance Evaluation of Air- borne Electronic Equipment and Systems	257
59 MIL-F-23447 (Wep) 14 Sep 62	Test and Installation of Radiation Sensing Type Aircraft Fire Warning Systems	227
60 MIL-P-25732B 11 Jan 67	Petroleum Hydraulic Fluid Resis- tant Preformed Packing, 275°F	123
61 MIL-P-38477A (USAF) 30 Aug 73	Pressure-Sensitive Adhesive Plastic Material for Aerospace Identification and Marking	196

TABLE XXIII - Continued		
Number	Title	Page
62 MIL-M-43719A 13 Jul 72	General Specification for Pigmented Elastomeric Adhesive Marking Materials and Markers	194
63 MIL-B-81819 (Proposed) Draft 4 Oct 73	High-Speed Self-Aligning Self-Lubricating Plain Bearings (-65° to +160°F)	63
64 MIL-B-81820A 31 Mar 72	Low-Speed Self-Aligning Self-Lubricating Plain Bearings (-65° to +325°)	66
<u>MILITARY STANDARDS</u>		
65 MIL-STD-108E 4 Aug 66	Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment	259
66 MIL-STD-202E 16 Apr 73	Test Methods for Electronic and Electrical Component Parts	168, 255
67 MIL-STD-454C 1 May 72	Standard General Requirements for Electronic Equipment	167, 205 254
68 MIL-STD-681B 6 Feb 67	Identification Coding and Application of Hookup and Lead Wire	208
69 MIL-STD-800 21 Jul 58	Procedure for Carbon Monoxide Detection and Control in Aircraft	244
70 MIL-STD-810B 21 Sep 70	Environmental Test Methods	91, 93
71 MIL-STD-882 15 Jul 69	Requirements for System Safety Program for Systems and Associated Subsystems and Equipment	218, 236
72 MIL-STD-1132 31 May 72	Selection and Use of Switches and Associated Hardware	170
73 MIL-STD-1247B 20 Dec 68	Markings, Functions, and Hazard Designations of Hose, Pipe, and Tube Lines for Aircraft, Missile, and Space Systems	209

TABLE XXIII - Continued		
Number	Title	Page
<u>FEDERAL SPECIFICATIONS</u>		
74 L-T-90C 3 Nov 65	Pressure-Sensitive Adhesive Tape (Cellophane and Cellulose Acetate)	211
75 L-T-99a 11 Sep 58	Pressure-Sensitive Adhesive Identification Tape (Acetate-Fiber)	212
76 L-T-100a 30 Aug 60	Pressure-Sensitive Adhesive Polyester Film Tape	213
77 FF-B-185 26 Dec 63	Cylindrical Roller Bearings and Self-Aligning Roller Bearings	84
78 PPP-T-60D 25 Jun 71	Waterproof Packaging Tape	215
79 PPP-T-66D 1 May 69	Pressure-Sensitive Adhesive Vinyl Plastic Film Tape	216
<u>MILITARY HANDBOOKS</u>		
80 MIL-HDBK-221 3 May 65	Fire Protection Design Handbook for U.S. Navy Aircraft Powered by Turbine Engines	221
<u>ARMY TECHNICAL MANUALS</u>		
81 TM 55-1500- 204-25/1 18 Jun 71	General Aircraft Maintenance Manual	148, 157 190
<u>AMC PAMPHLETS</u>		
82 AMCP 706-203 Apr 72	Engineering Design Handbook-- Helicopter Engineering, Part Three, Qualification Assurance	87, 126, 135, 223, 241, 258
<u>OTHER DOCUMENTS</u>		
83 AFSC DH 1-X 15 Jan 74	Checklist of General Design Criteria, Chapter 6, System Safety	220
84 AFSC DH 1-6 20 Jan 74	System Safety	219

TABLE XXIII -- Continued

Number	Title	Page
85 SCL-I-0019B 1 Apr 65	Installation of Radio Set AN/ARC-54() in Army Aircraft	260
86 SCL-I-0020 20 Apr 64	Installation of Radio Set AN/ ARC-51()X in Army Aircraft	262
87 SCL-I-0053A 27 Oct 66	Installation of (VHF) Radio Set AN/ARC-134() (Wilcox 807A) in Army Aircraft	264
88 SCL-T-0019B 1 Apr 65	Bench, Preflight, and Flight Testing of Radio Set AN/ARC- 54() for Army Aircraft	266
89 SCL-T-0020 20 Apr 64	Bench, Preflight, and Flight Testing of Radio Set AN/ARC- 51()X for Army Aircraft	267
90 SCL-T-0053B 30 Nov 66	Bench, Preflight, and Flight Testing of (VHF) Radio Set AN/ARC-134() (Wilcox 807A) for Army Aircraft	268
91 USAF Spec Bulletin 526a 19 Apr 67	Maximum Allowable Concentration of Cabin Air Contaminants	237